



Exploring the nature of early social preferences: The case of music

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Abstract

This dissertation aims to explore the nature of early social preferences by testing attention to a cue that might have evolved as a reliable signal of shared group membership – shared cultural knowledge. Part 1 shows that children attend to this cue when making social choices: Children both prefer others who know songs they themselves know, and avoid others who know songs they do not know, while other cues such as shared preferences for songs are not as powerful drivers of social preferences.

Part 2 shows that this cue affects how five-months-old infants allocate attention to human singers. After listening to two individuals singing different songs, infants look longer at singers of familiar songs than at singers of unfamiliar songs. When both songs are unfamiliar, infants do not show preferences for singers of songs that follow or violate Western melodic structure, although they are sensitive to these differences. In focusing on familiar songs but not musical styles, infants may selectively attend to information that might mark group membership later in life, namely shared knowledge of specific songs.

Part 3 investigates whether children are selective in the properties they use to infer that two individuals belong to the same group, targeting two potentially important social cues: race and gender. Specifically, Part 3 asks if children attribute shared musical

knowledge to individuals of the same race or gender. Four-year-olds attribute shared knowledge to individuals of the same gender, but not of the same race. Five-year-olds attribute shared knowledge to individuals of the same race, but not of the same gender. In contrast, a control unrelated to group-membership – attributions of shared musical preferences – do not yield any dissociation between attributions based on race or gender. Thus, as they gain experience, children seem to adaptively update the social cues they use to infer shared group-membership.

Together these results begin to elucidate the mechanisms underlying early social preferences by showing that children might selectively attend to the most reliable cues to shared group-membership, which, in turn, might allow them later in life to participate in the complex social organization that is unique to human societies.

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Introduction

Humans are an exquisitely social species where an individual's fitness depends on successfully negotiating the complexities of human societies. To navigate this social environment, we divide it into remarkably complex and flexible groups and categories, based on criteria as diverse as race, gender, political affiliation, religion, language and preferences for sport teams or music groups. Social categories serve as the basis for rapid inferences about socially relevant traits of members of a given category, and, when faced with a member of a category, adaptive behavior is contingent on these inferences. Further, this categorization has crucial social ramifications, ranging from selectively interacting with some individuals over others to prejudices and discrimination and, in severe but frequent cases, to riots, wars and genocides. Moreover, these tendencies arise early in life, with even young children preferring some individuals over others based on various social categories such as gender, race, or language.

While social categorization is clearly important, what is less clear, and subject to considerable debate, are the sources of these tendencies. Do we learn through experience which cues to attend to for efficient social categorization, and which inferences to base on such cues? Or have we evolved to attend to specific kinds of cues, to draw specific kinds of inferences? And, in either case, how do such processes develop over time?

This dissertation aims to begin answering these questions by using early music-based social preferences in infants and children as a case study. Music is particularly conducive to studying such questions, because it is a cultural product that has varied across social groups throughout history and is, therefore, a potential cue to group membership.

Early social categories and the development of social preferences

Race, gender and age are considered to be the three major, perceptually salient, social categories by which adults organize their social world (Brewer, 1988; Fiske, 1998). Research suggests that these social categories are already present in early childhood and influence children's social choices. Children between the ages of 2 to 5 tend to prefer individuals of their own gender, race, and age as revealed by children's friendship choices in their natural social environments as well as in laboratory settings (French, 1987; Kircher & Furby, 1971; Kowalski & Lo, 2001; La Freniere, Strayer, & Gauthier, 1984; Maccoby & Jacklin, 1987; Martin & Fabes, 2001; Martin, Fabes, Evans, & Wyman, 1999; Martin, 1989). Pre-school children also assign more positive attributes to individuals of their own gender (Albert & Porter, 1983; Yee & Brown, 1994), as well as to individuals of their own race, at least in cases where the race has high status (Aboud, 1988; Bigler & Liben, 1993). In addition to these traditional social categories, recent research suggests that young children also pay attention to language as a social cue. For example, when presented with two children speaking different languages, five-year-old children prefer to be friends children who speak their native language rather than with children who speak a foreign language (Kinzler, Dupoux, & Spelke, 2007). Moreover, not only native languages but even native accents are powerful drivers of early social preferences; when pitted against race, accent has a stronger effect on social preferences than race (Kinzler, Shutts, DeJesus, & Spelke, 2009).

In addition to showing social and evaluative preferences, children also make inferences about other individuals' properties and preferences based on these social

categories. For example, preschool-age children use gender information to predict individuals' preferences for familiar objects such as dolls and trucks (Bauer & Coyne, 1997; Kuhn, Nash, & Brucken, 1978; Leinbach, Hort, & Fagot, 1997; Martin, 1989; Martin & Little, 1990; Reis & Wright, 1982). Children also use category information to make inferences about novel biological properties or preferences for novel activities and objects (Gelman, Collman, & Maccoby, 1986; Hirschfeld & Gelman, 1997; Diesendruck & haLevi, 2006). Moreover, these social categories do not only guide children's preferences for other humans, but also for novel activities and objects. For instance, three-year-old children prefer novel activities (e.g., playing with a *spoodle*) that are preferred by children of their own gender, age and in some circumstances race (Shutts, Banaji, & Spelke, 2010).

Attention to social categories is already present earlier in infancy. This conclusion is based on studies investigating how infants allocate visual attention to individuals, and how they choose whom to interact with. Indeed, young infants seem to be remarkably selective in whom they preferentially attend to (and whom they preferentially ignore), based on various physical and behavioral traits. For instance, infants preferentially attend to characters who help others over characters who hinder others (Hamlin, Wynn, & Bloom, 2010), to people who speak in an infant-directed style as opposed to adult-directed style (Schachner & Hannon, 2011), to people who speak their native language with a native accent as opposed to those who speak in a foreign language or accent (Kinzler, Dupoux & Spelke, 2007), and to faces of a familiar race and gender (Bar-Haim, Ziv, Lamy, & Hodes, 2006; Kelly, et al., 2005; Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002).

However, while the methods used in these experiments reveal how infants allocate attention to human agents as a function of various behavioral or physical cues, they do not reveal whether infants' preferences are truly social in nature, or whether they reflect more general affective responses. For instance, while some cues (e.g., language) produce similar patterns of preferences with more direct social measures across different ages, others (e.g., race) do not (Kinzler et al., 2007; Kinzler & Spelke, 2011). Specifically, while 10 month-old infants preferentially accept toys from a native language speaker rather than a foreign-language speaker, infants' have no preference when choosing between two unfamiliar individuals who differ in terms of race (Kinzler et al., 2007; Kinzler & Spelke, 2011), although infants prefer to look at both same-language individuals and same-race individuals at even younger ages. As a result, it is unclear whether the looking time preference for some individuals over others reflects truly social biases.

Mechanisms underlying early social choices

While children and even infants are clearly sensitive to attributes that will be socially important later in life, it is unclear what drives these early preferences. There are several possibilities. First, these social preferences might be based on mechanisms that guide preferences in nonsocial as well as social contexts, such as a preference for objects or events that are familiar (e.g., Zajonc, 1968). In other words, these early social preferences might simply be driven by a preference for any object, event or pattern that is familiar (e.g., Zajonc, 1968), coupled with an associative process of "affective tagging" (see below) that leads individuals to prefer other individuals who are associated with

preferred objects, events or patterns (e.g., De Houwer, Thomas, & Baeyens, 2001; Manis, Cornell, & Moore, 1974). For example, Olson, Banaji, Dweck and Spelke (2006) introduced six year-old children to two groups that differed by their T-shirt color. Most members of one group were lucky (i.e., they were described as having had experienced a positive event like finding a \$5 bill on the sidewalk). Most members of the other group were unlucky (i.e., they were described as having experienced a negative event like the cancellation of their soccer game). Children were then introduced to two new individuals belonging to each group and asked whom they liked more. Children preferred individuals from the *lucky* group rather than the *unlucky* group, even though the groups were completely arbitrarily constructed, and children had no knowledge of the new members except for the group they belonged to.

While a generic preference for familiar stimuli as well as the individuals associated with them might explain many experiments demonstrating “social” preferences in early years of life, there is also some evidence suggesting that it might not be sufficient to account for other forms of early social preferences. For instance, in childhood, certain social categories seem to be more privileged than others. As mentioned above, five-year-olds prefer native accented children and own-race children. However, when these two cues are pitted against each other, accent overcomes the effects of race in terms of social preferences (Kinzler, et al., 2009): Children choose to be friends with other-race, native-accented individuals rather than a same-race, foreign-accented individuals (Kinzler et al., 2009). Crucially, when children had to choose between normal and distorted faces that were paired with foreign-accented and native accented speech, respectively, children still preferred the native-accented individuals. Given that children

are even less familiar with distorted faces than with other-race faces, such results would suggest that mere familiarity with stimuli does not seem to drive social preferences (Kinzler et al, 2009).

A second possible mechanism underlying children's and adults' social choices is the perceived similarity between two individuals. For adults and adolescents, perceived similarity between two individuals leads to interpersonal liking and friendship. For instance, adults prefer others who are similar to themselves in attitudes (Byrne & Nelson, 1965; Neimeyer & Mitchell, 1988), behaviors (Urberg, Degirmencioglu, & Tolson, 1998), preferences (Billig & Tajfel, 1973; Brewer & Silver, 1978), and values and background (Johnson, 1989). Children have also been shown to prefer others who are similar in attitudes (Byrne & Griffitt, 1966), behavior, (Haselager, Hartup, van Lieshout, & Riksen-Walraven, 1998), physical appearance (Fawcett & Markson, 2010).

While the mechanisms discussed so far are social in the sense that they lead to preferences for some individuals over others, they do not connect to a crucial aspect of the organization of human societies: its organization into social groups. Throughout history, humans have lived in groups, where members of the same group mutually interact and cooperate with each other, while members of different social groups compete for resources. Therefore, it is crucial for members of a group to learn who is in their group and who is not.

If children's social choices rely on the mechanisms discussed so far, children might prefer certain individuals because of some other, non-social factors (e.g., speaking a familiar sounding language, looking alike or being associated with positive affect), with no inferences about membership in social groups at all. These preferences might be

associated with social groups only later in life when they shape adult-like divisions of the social landscape. In contrast to this possibility, it is also possible that, from very early on, children might be sensitive to certain attributes that mark the group membership of potential social partners, and that this distinction drives their social choices even very early in life.

Sensitivity to the ingroup-outgroup distinction

It has been argued that attention to cues that mark in-group and out-group membership might provide considerable fitness benefits by allowing individuals to successfully track coalitional alliances in their environment (Kurzban, Tooby, & Cosmides, 2003). Indeed, the mere act of categorizing individuals into social groups suffices to produce differential attributions of characteristics and differential allocation of resources to these individuals (Brewer, 1979; Tajfel, Flament, Billig, & Bundy, 1971). Similar behaviors have been observed with children, where the “minimal group” divisions can be based on completely arbitrary groupings, such as the random assigning children to groups based on T-shirt colors (Bigler, Jones, & Lobliner, 1997), or dividing children into groups based on no apparent criteria at all (Sherif, Harvey, White, Hood, & Sherif, 1961). Such groups yield implicit and explicit attributions of positive and negative characteristics towards individuals based on these rather arbitrary cues (Bigler, Jones, & Lobliner, 1997; Dunham, Baron & Carey, 2011; Olson et al., 2006; Sherif, Harvey, White, Hood, & Sherif, 1961).

While young children make social choices and assign different attributes to individuals based on different cues like accent, race or gender, there is no clear evidence

that these behaviors are in fact based on their inferences about group-membership of the potential social partners. For example, when we encounter individuals speaking with a foreign accent, we can make a variety of inferences that differ in their scope. We might make inferences ranging from concluding that these individuals will not understand us, to that it will be difficult to cooperate with them to that they are dissimilar to us in various ways to that they are members of a different cultural group. These inferences may have various kinds influences on how we would interact with these individuals. Further, if any of these inferences is made, one might ask why we make such inferences. Again, there is a continuum of possibilities, from associative mechanisms akin to conditioned preferences to rational thought about which inferences are and are not licensed to inferential biases and heuristics akin to those prevalent in decision making that evolved to lead us to make fast and adaptive social inferences (Tversky & Kahneman, 1974; 1981; Todd & Gigerenzer, 2000). In line with the latter possibility, this dissertation proposes a particularly promising cue for evaluating shared group membership: shared knowledge of cultural traditions.

Shared cultural knowledge as a reliable cue to group-membership

When two individuals encounter each other, how can they determine whether they are members of the same group? Shared cultural knowledge might be a particularly reliable cue to group membership. Before the introduction of modern means of distributing knowledge (e.g., books, recordings, television and the internet), knowledge could only be transmitted by means of direct social interactions, making shared cultural knowledge a particularly potent cue to group membership, especially in preindustrial

societies. For example, members of a group share knowledge about traditions, folk tales or, songs. As a result, if one individual encounters another, unfamiliar individual who demonstrated knowledge of the melody and lyrics of a song or another culture-specific social practice that was known to the first individual, it was highly likely that a chain of direct social contacts linked the two individuals.

While cultural traditions are associated with other potential cues, shared knowledge seems to be particularly conducive for inferring group membership. Shared preferences are a case in point for a cue that might be associated with cultural traditions, and yet might not be a reliable cue to group-membership. Several strands of research in social psychology suggest that shared preferences affect adults' and children's social choices (e.g., Billig & Tajfel, 1973; Brewer & Silver, 1978, Fawcett & Markson, 2010). However, there are reasons to think that shared preferences are not informative about group membership. After all, they might have many different sources, including previous exposure and familiarity or some other intrinsic factors. As an example, musical preferences are influenced by many factors including the structure of the ear, exposure, cultural background as well as personality characteristics (Denisoff & Levine, 1972; Masataka, 2006; Rentfrow & Gosling, 2003; Soley & Hannon, 2010). Moreover, preferences are subject to change throughout the course of the lifespan (e.g., LeBlanc, Sims, Siivola, & Obert, 1996). As a result, preferences are not necessarily shared by the members of a given social group, and might well be shared by members of different groups. Compared to shared cultural knowledge, shared preferences thus appear to be less useful for inferring group membership.

Hence, from an evolutionary perspective, shared cultural knowledge might

reliably identify members of one's own group, because, at least in pre-modern societies, cultural knowledge could be transmitted only through direct social contact. Consequently, humans might have developed biases to preferentially attend to this cue to identify in-group members compared to other cues that are not as reliable markers of group membership.

Using music-based social preferences to explore the nature of early social categories

Music provides an ideal domain of investigation of the underlying mechanisms of early social preferences for several reasons. First, cultural groups have been distinguished by their music as well as their languages, making both potential cues to group-membership. Through everyday exposure to music, individuals acquire an implicit knowledge about the structure and rules of the music of their culture, such as the pitch organization in Western music (for a review, see Bigand & Poulin-Charronnat, 2006) or the rhythmic patterns typical of their own musical culture. Moreover, this implicit knowledge of culture-specific musical regularities often leads to difficulties in understanding emotions that are conveyed by an unfamiliar tune of a different culture (Gregory & Varney, 1996; Morey, 1940) or remembering novel music from another culture (Demorest, Morrison, Beken, & Jungbluth, 2008).

Second, even very young infants show a remarkable sensitivity to musical stimuli. Exposure to music starts prior to birth (Kisilevsky, Hains, Jacquet, Granier-Deferre & Lecanuet, 2004) and young infants can recognize familiar tunes (Hepper, 1991) and distinguish different rhythmic and melodic patterns (for a review, see Trehub, 2003). The culture-specific knowledge about the pitch structure in music is acquired in childhood

(Koelsch et al., 2003; Schellenberg, 2005; Trainor & Trehub, 1994), or, in the case of rhythm, already during the first year of life (Hannon & Trehub, 2005a; 2005b).

Third, music might serve as a cue to social group membership, and an influence on social preferences in adolescence and adulthood. For example, adults make inferences about others based on their musical taste: they use others' preferences for certain musical genres as a cue to their individual, social and ethnic characteristics (Litle & Zuckerman, 1986; Rentfrow & Gosling, 2003; 2007; Rentfrow, McDonald & Oldmeadow; 2009). Furthermore, individuals attribute more positive characteristics to fans of musical genres they themselves like (Bakagiannis & Tarrant; 2006; Lonsdale & North, 2009; North & Hargreaves, 1999; Tekman & Hortacsu, 2002); likewise, musical taste plays a crucial role in friendship formation, especially among adolescents (Epstein, 1994; Johnstone & Katz, 1957; Selfhout, Branje, ter Bogt, & Meeus, 2009).

Finally, music also allows testing different types of shared knowledge and test predictions about the relative usefulness of these cues in signaling group membership. For example, knowledge of musical stimuli can be shared on at least two levels. First, individuals can share abstract knowledge about culture-specific musical styles, such as Western, Balkan or Chinese music. However, while musical styles vary to a considerable degree, they vary only over large geographical distances. In particular, ethnomusicologists divide the world into just seven to ten musical areas, based on the variation in rhythmic and melodic structure (Nettl, 1983). For example, the traditional music of many countries in South-Eastern Europe (e.g., Bulgaria, Macedonia, Turkey) features similar complex rhythms (Bates, 2010; London, 1995; Rice, 1994) that are not found in the music of other parts of Europe. As a result, each of the musical areas covers

a large geographic range comprising many different human groups. Under these conditions, knowledge of culture-specific musical traditions may not be very informative concerning the groups to which unfamiliar individuals belong.

Second, individuals can be familiar with specific songs; as mentioned above, such shared knowledge would be an important cue to shared group membership. After all, familiar songs are transmitted across generations only by direct social contacts in cultures lacking modern devices such as radios and audio recordings. Unlike musical styles, however, the individual songs that accompanied the rituals and celebrations of one social group were unlikely to be shared by neighboring groups who spoke different dialects (and therefore would not use the same lyrics), and developed different rituals and social practices. Thus, from this perspective, familiarity with specific songs might arguably be a better cue to group membership.

In summary, music, as well as the social preferences associated with it, provides us with a complex and understudied web of interactions between perceptual and social biases and preferences, and with the tools to explore the nature of these preferences by specifically testing the relative impact of shared knowledge and preferences on social preferences in early life.

The present research

This dissertation investigates the nature of early social preferences and categories, using music-based social preferences as a case study. Do early social preferences reflect children's sensitivity to ingroup-outgroup distinction or are they based on other, perhaps emotional, biases which children entertain independently of their social environment?

Are young infants selective in allocating their attention to cues when preferring one individual over another, and, if so, do they preferentially attend to cues that come to mark group membership later in life? Finally, do similar mechanisms underlie children's social judgments when they categorize individuals based on different social cues such as gender and race?

Part 1 of this dissertation explores the nature of early social preferences by asking whether children selectively attend to cues that might be privileged markers of an individual's group membership. Specifically, Part 1 asks whether four and five-year old children would preferentially choose their friends based on shared cultural knowledge, or rather based on shared preferences. This issue was tested using music-based social preferences in children. The results first established that music modulates children's social choices, and that four and five year-old children preferred other children whose favorite songs are consonant or familiar to them. The results further showed that children's preferences are selectively driven by a shared state of cultural knowledge: When children had to choose one of two children who differed in terms of their knowledge of and/or of their preferences for a familiar or an unfamiliar song, children both preferred others who knew songs they themselves knew, and avoided others who knew songs they did not know, irrespective of the target children's preferences for the songs. Further, children had no preference between potential social partners whose favorite songs differed in terms of musical structure (e.g., Western vs. Balkan songs), even though they could reliably identify Western songs as more familiar than Balkan songs; while knowledge of musical styles such as Western and Balkan music also constitutes cultural knowledge, this knowledge is, as discussed above, not a reliable cue

to group membership. Hence, children specifically attend to those forms of shared cultural knowledge that are reliable cues of shared group membership.

Part 2 investigated whether selective attention to familiar songs is present already in the first year of life. Specifically, this part asked whether and how music affects five-months-old infants' visual preferences for human singers. Infants were presented with two people singing different songs. Subsequently, when both singers were presented silently, infants looked longer at the singers of familiar songs over singers of unfamiliar songs. In contrast, when both songs were unfamiliar, infants did not prefer singers of songs that followed Western melodic structure over singers of songs that violated it, although they are sensitive to these differences. Hence, like older children, familiarity with specific songs may play a more privileged role in guiding infants' allocation of attention to potential social partners than familiarity with the general musical structure of one's own culture. These results, thus, suggest that even young children might selectively attend to information that will come to mark group membership later in life, although, as will be discussed in more detail below, some familiar melodies might have other properties that might make them preferable.

The results of Part 1 and 2 suggest that shared cultural knowledge might be a reliable marker of social group membership and that young children are sensitive to this cue. Building on these results, Part 3 asked whether children are selective in the properties they use to infer that two individuals belong to the same group, and whether they make other, group-unrelated inferences based on some or all of these properties. This question was approached by asking if children attribute shared musical knowledge or shared music preferences to individuals of the same race or gender. Four-year-olds

attributed shared knowledge to individuals of the same gender, but not of the same race.

In five-year-olds the pattern was reversed: they attributed shared knowledge to individuals of the same race, but not of the same gender. Further, other inferences (e.g., attribution of shared preferences) did not yield any dissociation between attributions based on race or on gender. Thus, children seem to update the role of social categories as they gain experiences to make adaptive inferences in their social environment.

Part 1: Shared cultural knowledge: Effects of music on young children's social preferences

Abstract

Children evaluate potential social partners based on various attributes that are, in adulthood, associated with prominent social categories. Do these early preferences reflect children's sensitivity to markers of potential social partners' group membership, or do they reflect emotional biases that become linked to social groups only later in life? Here, we use social preferences based on music to investigate this question in four and five year old children. First, we establish that children prefer other children whose favorite songs are consonant or familiar to them. Then we show that the latter effect depends on shared knowledge: children both prefer others who know songs they themselves know, and avoid others who know songs they do not know, irrespective of the target children's preferences for the songs. These results suggest that young children have a remarkably selective sensitivity to shared cultural knowledge, likely a highly informative marker of group membership over the time scale of human evolution.

Introduction

The human social world is remarkably complex and variable, with social groups and categories based on criteria as diverse as race, gender, political affiliation and preferences for sports teams. Nevertheless, the sources of adults' tendencies to divide the social landscape into groups are obscure and subject to debate. Do young children's social preferences reflect their sensitivity to markers of other people's social group membership, or are they mediated by other mechanisms? In the experiments presented below, we use social preferences based on music to begin to distinguish these possibilities.

Some of the social biases that are prominent in adulthood are already present in early childhood. For example, children aged 2 to 5 years tend to prefer individuals of their own gender, race, and age (Aboud, 1988; Alexander & Hines, 1994; French, 1987; Kircher & Furby, 1971; Kowalski & Lo, 2001; Martin, Fabes, Evans, & Wyman, 1999), as well as individuals who speak in their native language or in their native accent as opposed to a foreign language or a foreign accent (Kinzler, Dupoux, Spelke, 2007). Moreover, when pitted against each other, accent overcomes the effects of race in terms of social preferences, suggesting that, from very early on, some cues are privileged over others in guiding social preferences (Kinzler, Shutts, DeJesus, & Spelke, 2009).

While children and even infants are clearly sensitive to attributes that will be socially important later in life, it is unclear what drives these early preferences. On one hand, these social preferences might be based on mechanisms that guide preferences in nonsocial as well as social contexts, such as a preference for objects or events that are familiar (e.g., Zajonc, 1968; but see Kinzler et al., 2009). Alternatively, children might be

favorably disposed toward any person who is associated with positive events (Olson et al., 2008). In either case, children might have biases to prefer specific individuals over others, without making any inferences about the social groups to which they belong.

Alternatively, children's social preferences might be mediated by their sensitivity to certain attributes that mark the group membership of potential social partners. When children meet a new person, they may attend specifically to information that helps to determine whether or not that person is part of their own social group. Children might, therefore, selectively attend to attributes that reliably distinguish group membership.

A particularly potent cue to group membership, especially in preindustrial societies, is shared cultural knowledge. For example, members of a group might share knowledge about traditions, folk tales and, most relevant to the current experiments, music. Before the introduction of modern means of distributing knowledge (e.g., books, recordings, television and the internet), shared knowledge could only be transmitted by means of direct social interactions: If one individual encountered another, unfamiliar individual who demonstrated knowledge of the melody and lyrics of a song or a culture-specific social practice that was known to the first individual, it was highly likely that a chain of direct social contacts linked the two individuals. Hence, from an evolutionary perspective, shared knowledge might reliably identify members of one's own group.

In seven experiments, we use music as a case study to explore the nature of early social preferences. Music is particularly conducive to testing such issues for three reasons. First, like language (a powerful driver of social preferences early in life: Kinzler et al., 2007; Kinzler et al., 2009), music has both universal and culture-specific properties, making it a potential useful marker of group membership in all cultures.

Universal properties of music perception include sensitivity to consonance and dissonance of tone intervals. Across cultures and across ages from infancy to adulthood, consonant tone intervals elicit more positive responses (Masataka, 2006; Trainor, Tsang and Cheung, 2002; Zentner & Kagan, 1996) and are processed more easily (Acker, Pastore, & Hall, 1995; Schellenberg & Trehub, 1994, 1996) compared to dissonant tone intervals.¹ Culture-specific properties of music include pitch organization and rhythmic patterns. Through everyday exposure to music, individuals acquire (implicit) knowledge about the structure and rules of the melodic and rhythmical structure of the music of their culture (for a review, see Bigand & Poulin-Charronnat, 2006). This culture-specific knowledge is acquired in childhood (Koelsch et al., 2003; Schellenberg, 2005; Trainor & Trehub, 1994), or, in the case of rhythm, already during the first year of life (Hannon & Trehub, 2005a; 2005b). Moreover, this implicit knowledge of culture-specific musical regularities often leads to an advantage in understanding emotions that are conveyed by an unfamiliar tune of one's own culture (Gregory & Varney, 1996; Morey, 1940) and in remembering novel music from that culture (Demorest, Morrison, Beken & Jungbluth, 2008).

Second, a large body of research provides evidence that music serves as a cue to social group membership and influences social preferences in adolescence and adulthood. For example, adults make inferences about others based on their musical taste: they use others' preferences for certain musical genres as cues to their individual, social and ethnic characteristics (Little & Zuckerman, 1986; Rentfrow & Gosling, 2003; 2007; Rentfrow,

¹Intervals (i.e., tone combinations) with frequency ratios comprising small integers are termed 'consonant', while intervals with frequency ratios with large integers are termed 'dissonant' (Dowling & Harwood, 1986).

McDonald & Oldmeadow; 2009). Furthermore, individuals evaluate fans of musical genres they themselves like more positively than fans of other musical genres (Bakagiannis & Tarrant; 2006; Lonsdale & North, 2009; North & Hargreaves, 1999; Tekman & Hortacsu, 2002), and musical taste plays a crucial role in friendship formation, especially among adolescents (Epstein, 1994; Johnstone & Katz, 1957; Selfhout, Branje, ter Bogt, & Meeus, 2009). Given that preferences for the musical structure of one's own culture are present already around the age of six months (Soley & Hannon, 2010), it is possible that music might drive social preference early in life as well.

Third, music allows us to test different levels of familiarity (e.g., familiarity with a musical style or with specific songs), as well as emotional responses evoked by musical performances. As a result, music provides us with a complex (and understudied) web of interactions between perceptual, emotional, and social biases and preferences. It gives psychologists tools with which to explore the nature and development of social preferences by specifically testing the relative impact of shared knowledge and shared preferences on children's social choices in early life.

In the experiments below, we first aim to establish that music can influence children's social preferences. Then we ask whether children's music-based social preferences are driven by a general preference for the familiar, by emotional reactions to individuals who are associated with events that evoke positive emotions, or by the more specific marker of group membership provided by shared knowledge.

In the first experiment, we adapt a method that has been used previously to reveal children's language-based social preferences (Kinzler et al., 2007) and use it to test for preferences for individuals whose "music" accords with universal rules of consonance.

We introduced four- and five-year-old American children to pictures of two children and presented them with two brief, computer-generated melodies, one with a consonant, harmonious accompaniment, and the other with a dissonant accompaniment. After each melody was described as "the favorite song" of one of the target children, participants were asked which of the two children they would rather have as a friend. Participants chose the target child whose favorite song was consonant, validating this method.

Accordingly, we used the method in Experiments 2-4 to explore which aspects of music are critical in guiding children's social preferences. In Experiments 2-4, we presented target children associated with two songs that differed on two dimensions of familiarity: familiarity of songs and familiarity of musical style (Western vs. Balkan).² These experiments provided evidence that children prefer other children whose favorite music is a song that they themselves know. In contrast, children showed no preferences between other children based on musical style.

While the goal of Experiments 1 to 4 was to test whether music can drive social preferences, we begin to explore the nature of these preferences in Experiments 5-7. The songs in Experiments 1 to 4 were always introduced as the favorite songs of the children on the pictures. This statement gives two kinds of information: that the child *knows* the

²In most Western music, time is equally divided into smaller units, creating isochronous meters. In contrast, in the music of the Balkans, non-isochronous meters are commonly used as well (London, 1995). That is, in Balkan meters, time is not always evenly divided, but can consist of alternations of groups of 2s and 3s (London, 1995). Similarly, even though music is universally based on scale structures where notes an octave apart are perceived and treated as similar, different musical systems divide octaves into different groups of notes that vary the pitch distances between two notes (Dowling & Harwood, 1986; Hulse & Page, 1988; Nettl, 1956). In our displays, all Western songs used traditional Western scales and isochronous meters (i.e., 3/4 and 4/4). In contrast, while some of our Balkan songs used different scales, they all had non-isochronous meters (i.e., 7/8 and 9/8).

song, and that she *likes* the song. An evolutionary perspective suggests that knowledge might be a more useful cue to social group membership than emotional responses (i.e., liking a song), given that for most of our species' existence, musical knowledge was exclusively transmitted from one individual to another, whereas musical preferences may always have had many sources. In contrast, several strands of research in social psychology suggest that shared preferences might affect children's social choices to the same extent as, or even more than, shared knowledge (e.g., Fawcett & Markson, 2010). In Experiments 5 to 7, therefore, we introduced participants to pictures of two children who differed in terms of their knowledge of and/or of their preferences for a familiar or an unfamiliar song (respectively, American children's songs and unfamiliar, 18th century American folk songs). Then we asked participants whom they would rather have as their friend.

Experiment 1

Experiment 1 was undertaken to validate our method. We tested whether children preferred other children who were associated with music that conformed to universal principles of harmony, relative to “music” that violated those principles. We asked whether consonant vs. dissonant music, presented as the favorite songs of potential social partners, would influence children's social preferences for those partners. We reasoned that if music has any effects on children's social preferences, then this effect should appear when children are presented with this strong musical contrast.

Method

Participants: Twenty-four children (9 girls: mean age: 4 y 8 m; range 4 y - 5 y 9 m) participated in Experiment 1. One additional child was eliminated from the final sample due to experimenter error. In Experiments 1 to 4, we selectively recruited children from families with both parents born and raised in the United States. We excluded any children from foreign families or who did not know the familiar melodies according to parental report. Children were recruited from the greater Boston area and tested in the Laboratory for Developmental Studies at Harvard University.

Displays: Visual displays consisted of 6 pairs of photographs of 5 year-old children (6 girls and 6 boys) that were matched based on adult ratings on attractiveness, positiveness and friendliness. Auditory accompaniments consisted of 12 computer-generated songs.³ All songs were unfamiliar American folksongs from the 18th century. An accompanying melody was added to all songs, so as to create consonant intervals. To create the dissonant versions of the songs, the accompanying melody was lowered by a semi-tone, creating intervals that were mostly dissonant for half of the songs. All songs in all experiments were created as MIDI files using the same instruments on GarageBand (Apple Inc., Cupertino, CA) and the song pairs on each trial were matched for duration and tempo.

Design and Procedure: Participants were shown photographs of two 5-year-old children on a computer screen one by one. As each photograph was shown, the experimenter played a song that was described as “the child’s favorite song”. After the songs were played, the two photographs were shown on the screen side by side, and the participant

³Sample songs are available online at http://www.wjh.harvard.edu/~gsoley/_/MFP.html

was asked, “Which one of these children would you like to be friends with?” Each participant received 6 trials with different pairs of photographs and songs. The order of the consonant and dissonant music as well as the lateral positions of the photographs was counterbalanced both across trials and across participants. Pairings of photographs to songs were counterbalanced across participants. Participants listened to the songs through the speakers of a laptop computer.

Data analysis: Percentages of choices of children associated with consonant songs were calculated for each participant, and the average of these scores across children was compared to the chance level of 50%, using a one-sample, two-tailed t-test. A binomial test, comparing the number of participants who preferred children associated with each type of music (after eliminating participants with no preference), was also conducted.

Results

Participants chose children whose favorite songs were consonant rather than dissonant ($M = 59\%$, $SD = 18\%$, chance = 50%), $t(23) = 2.5$, $p < .05$ (see Figure 1.1a). Thirteen participants mostly chose pictures associated with consonant songs, whereas three mostly chose the pictures associated with dissonant songs and 8 had no preference ($p = .021$, binomial test).

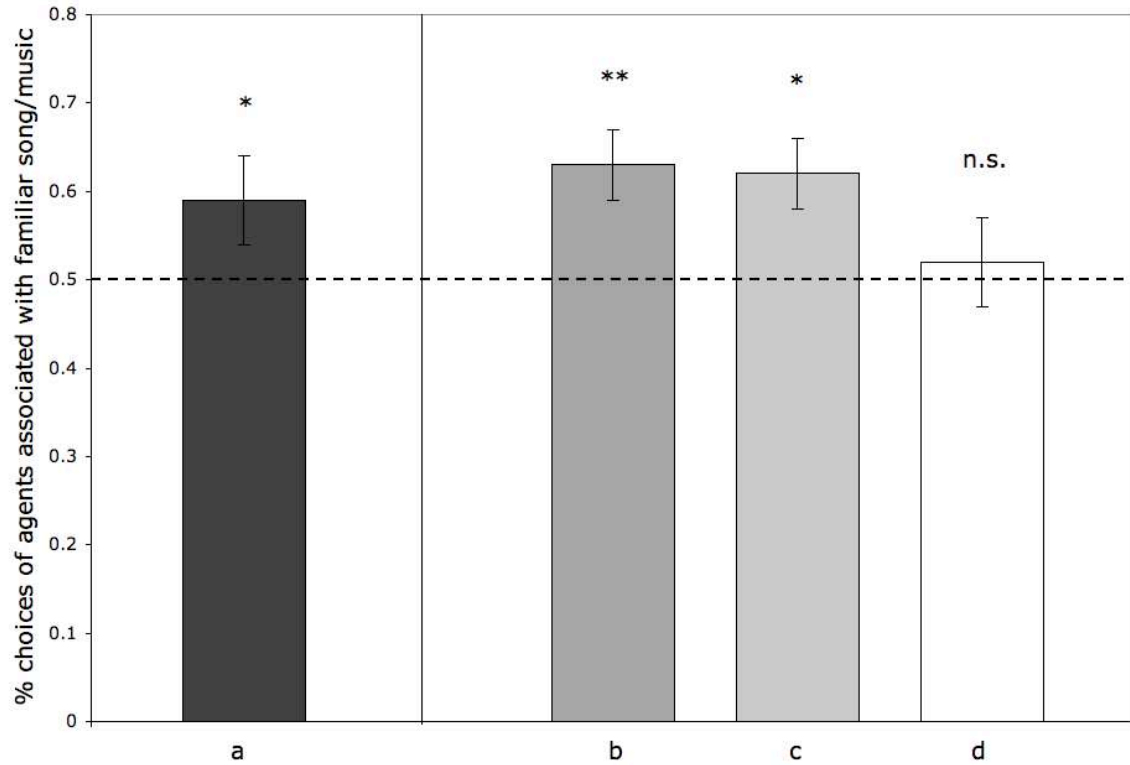


Figure 1.1. Results of Experiments 1-4. Mean friendship choices associated (a) with consonant songs in Experiment 1, (b and c) with familiar Western songs in Experiment 2, and Experiment 3, and (d) with unfamiliar Western songs in Experiment 4. Error bars represent standard errors (* = $p < .05$, ** = $p < .01$).

Discussion

The results of Experiment 1 provide evidence that children prefer other children whose favorite songs are consonant rather than dissonant: a universal constraint on musical structure. This finding indicates that music can drive young children's social preferences and that the present method can reveal such effects. Accordingly, the next three experiments asked what aspects of music influence children's social preferences when they are presented with melodies that all accord with universal musical melodic principles, and that differ in their familiarity, musical style, or both.

Experiment 2

In Experiment 2, we investigated whether music modulates children's friendship choices when the favorite songs of the potential social partners all conformed to universal musical rules, but differed both in familiarity and in musical style.

Method

Experiment 2 used the method of Experiment 1 except as follows. Participants were 24 children (14 girls: mean age: 4 y 10 m; range 4 y - 5 y 7 m). Two additional children were excluded from the final sample due to failure to finish the experiment. Auditory stimuli consisted of 12 computer-generated songs, presented without lyrics. Six of the songs were Western popular children's songs (e.g., "Mary Had a Little Lamb", "Row Row Row Your Boat"), and six were Balkan folk songs with unfamiliar melodies presenting melodic and rhythmic structures that are foreign to Western music.

Results and Discussion

Children tended to choose as a friend the target children whose favorite songs were familiar songs in the style of Western music ($M = 63\%$, $SD = 22.1\%$), $t(23) = 3.1$, $p < .01$ (see Figure 1.1b). Fifteen participants mostly chose the pictures associated with the familiar songs, whereas 4 participants mostly chose the pictures associated with the unfamiliar Balkan songs and 5 had no preference ($p = .019$, binomial test). Thus, the favorite songs of potential partners modulated children's social preferences when the songs differed in familiarity and musical style.

Experiment 3

In Experiment 2, the children's preferences could be driven either by familiarity with specific songs, or by familiarity with the music of the children's own culture. In

Experiment 3, we asked whether familiarity with specific songs was sufficient to guide social preferences.

Method

The method was the same as Experiment 1 except as follows. Participants were 24 children (13 girls: mean age: 4 y 7 m; range 4 y - 5 y 10 m); 5 additional participants were excluded from the final sample because their parents were foreign or indicated that their children were not familiar with the American children's songs. Auditory stimuli consisted of 12 computer-generated excerpts. Half of the songs were 18th century American folk songs with the melodic structure of contemporary Western music, and half were the popular American children's songs used in Experiment 2.

Results and Discussion

As shown in Figure 1.1c, participants tended to choose as friends the target children whose favorite songs were familiar songs in the style of Western music, relative to children whose favorite songs were unfamiliar songs in the same style of Western music ($M = 61\%$, $SD = 21\%$), $t(23) = 2.6$, $p < .05$. Fifteen participants mostly chose targets associated with familiar Western songs, whereas 4 participants mostly chose targets that were associated with unfamiliar Western songs and 5 participants had no preference ($p = .02$, binomial test)⁴. A 2 (Experiment: 2 vs. 3) by 2 (Music type: familiar

⁴Because we used actual Western children's songs and folk songs, the familiar and unfamiliar songs differed in some dimensions, which may potentially have influenced the perceived complexity of these songs. For example, melodies with more changes in pitch direction might sound more complex. However, in Experiment 3, on half of the trials, the familiar songs had fewer directional contour changes than the unfamiliar songs, while the reverse held true on the remaining trials. To assess the influence of this factor, we replicated our analyses by including only the subset of trials where the familiar songs had at least as many directional contour changes as the unfamiliar songs. In these three trials, participants chose target children whose favorite songs were familiar songs in the style of

vs. unfamiliar music associated with the target child) mixed factor ANOVA, performed on the number of trials on which participants chose the child associated with each type of music, revealed a significant main effect of music type, $F(1,46) = 16.0, p < .001$, no significant main effect of experiment, $F(1,46) < 1$, and no significant interaction, $F(1,46) < 1$.

In contrast to Experiment 2, the songs in Experiment 3 differed only in how familiar they were to the participants, but not in terms of their culture-specific musical properties. As participants reliably chose the target child associated with the familiar songs in both experiments, these results confirmed that song familiarity is sufficient to drive social preferences in children.

The combined results of Experiments 2 and 3 suggest that participants are equally likely to choose friends based on their favorite songs when the songs differ both in their familiarity to the children and in their culture-specific conventions, and when they differ only in their familiarity. This finding raises the possibility that culture-specific properties of the songs used in Experiment 2 are irrelevant for the participants' social preferences,

Western music significantly more often than target children whose favorite songs were unfamiliar songs in the same style of Western music ($M = 70\%$, $SD = 25\%$), $t(23) = 4.03$, $p < .001$. Twenty participants mostly chose targets associated with familiar Western songs, whereas 4 participants mostly chose targets that were associated with unfamiliar Western songs ($p = .0015$, binomial test). Hence, even when considering only the putatively more complex songs, children preferred individuals associated with familiar melodies. A second factor that might have influenced the perceived complexity of the melodies is the number of leaps (i.e., the number of transitions between tones larger than one scale step). To address this issue, we calculated the number of leaps in each melody, and analyzed those trials where the familiar song had at least as many leaps as the unfamiliar song. Because this constraint left us with only two trials per participant, we compared children's choices on the trials where the familiar songs had fewer leaps than the unfamiliar songs ($M = 63\%$, $SD = 23\%$) to those two trials where the number of the leaps in familiar song was greater than the unfamiliar song ($M = 63\%$, $SD = 39\%$), $t(23) < 0.001$, $p > .999$, two-tailed, paired sample t-test. Thus, these factors do not seem to have contributed to children's choices in Experiment 3.

and that the social preferences might be driven exclusively by the familiarity with the songs, irrespective of whether or not the unfamiliar song conformed to the rules of Western music. We test this possibility in Experiment 4.

Experiment 4

In Experiment 4, the potential social partners' favorite songs were all unfamiliar to participants, but half conformed to the conventions of Western musical culture whereas the others came from a different culture. If familiarity with culture-specific musical styles plays a role in the establishment of social preferences, we would expect participants to prefer children associated with songs from their own culture over songs from a different culture, even if both songs are unfamiliar.

Method

The method was the same as Experiment 1 except as follows. Participants were 24 children (8 girls: mean age: 4 y 7 m; range 4 y - 5 y 7 m). Two additional children were excluded from the final sample due to failure to finish the experiment. Auditory stimuli consisted of 12 computer-generated songs. Six of the songs were the unfamiliar American folk songs from the 18th century used in Experiment 3; the other six songs were the unfamiliar Balkan folk songs used in Experiment 2.

To determine whether children can identify the Western musical style as more familiar than the Balkan musical style, we presented a separate group of 20 children (9 girls: mean age: 4 y 11 m; range 4 y - 5 y 11 m) with the same song pairs, and we asked them which of the two songs sounded more like the songs they know. These children chose the unfamiliar Western folk songs significantly more often than the unfamiliar

Balkan songs ($M = 65\%$, $SD = 15\%$), $t(19) = 4.4$, $p < .001$. Thirteen children mostly chose Western songs, whereas only one child mostly chose Balkan songs; the remaining six children had no preference ($p = .002$, binomial test). Hence, young children readily discriminated the unfamiliar Western songs from the unfamiliar Balkan songs used in this experiment, and know that western songs are more like the songs they know even if they have no experience with the specific songs.

Results

Figure 1.1d shows the results of Experiment 4. Children showed no tendency to choose as friends other children whose favorite songs conformed to the melodic and rhythmic conventions of Western music; when both songs were unfamiliar, their preference for children associated with Western music ($M = 52\%$, $SD = 23\%$) did not differ significantly from chance, $t(23) = .57$, $p > .5$, ns. Nine participants mostly chose pictures that were associated with the unfamiliar Western songs, 6 children mostly chose the pictures that were associated with the unfamiliar Balkan songs, and the other 9 children showed no preference ($p = .61$, binomial test).

Further analyses compared the preferences of children in Experiment 4 to those in Experiment 2, who also were presented with Western and with Balkan melodies but for whom the Western songs were familiar. This 2 (Experiment: 2 vs. 4) by 2 (Music type: Western vs. non-Western music associated with the target child) mixed factor ANOVA, performed on the number of trials on which participants chose the child associated with each type of music, revealed a significant main effect of music type $F(1,46) = 6.1$, $p = .017$, but no significant main effect of experiment, $F(1,46) < 1$, and no significant interaction, $F(1,46) = 2.6$, $p = .11$. Thus, children's preference for music in the Western

style was no greater than chance in Experiment 4 but failed to differ significantly from their preference for familiar songs in Experiment 2.

Discussion

Although Experiments 1-3 provide evidence that the favorite songs of potential social partners affect children's evaluation of these partners when the songs differ in terms of familiarity or in terms of their adherence to universal musical rules, Experiment 4 provides no evidence that the favorite songs affect children's social preferences when they exhibit an abstract level of familiarity by conforming to a culture-specific style of music. The negative findings of Experiment 4 cannot be explained by children's failure to discriminate between the musical styles of the two different cultures, because a separate group of children, drawn from the same population, readily identified the songs in the Western musical style as more similar to the songs they know than those in the Balkan musical style.

Nevertheless, we cannot rule out the possibility that familiarity with culture-specific musical styles might contribute to social preferences, and we note that the findings of Experiment 4, while not showing a significant preference, also did not differ significantly from those of Experiment 2, in which children did show a reliable preference. We conclude only that familiarity with specific songs is sufficient to drive social preferences when children are tested with the present methods, whereas familiarity with the cultural conventions of songs may not. When target children are described as preferring different songs, children's knowledge of the specific songs appears to exert a powerful affect on their social choices.

Interim Discussion

The findings that familiar songs guide children's social choices, but familiar musical styles do not, are striking, because culture-specific musical styles have many properties that might make them good cues to group membership. For example, implicit knowledge about culture-specific aspects of music is acquired early in life; it leads to preference for music of one's own culture even in early infancy (Soley & Hannon, 2010); and it leads to various impairments when processing the music of a different culture or the associated emotions (e.g., Demorest et al., 2008; Morey, 1940). Moreover, in some situations, such knowledge is clearly a marker of group membership. For instance, in a social gathering where people dance together to music (e.g. a traditional wedding with Balkan music), individuals with limited exposure to Balkan rhythms would be conspicuous out-group members, because of their difficulties dancing or clapping to these rhythms (Snyder, Hannon, Large & Christiansen, 2006). Hence, in such situations, implicit culture-specific knowledge about musical conventions would provide a reliable cue for identifying out-group members.

However, evolutionary considerations suggest two reasons why humans might not have evolved a predisposition to use knowledge of culture-specific musical traditions to determine group membership. The first reason relates to the important individual variability in the abilities to produce music (Pfordresher & Brown, 2007; Pfordresher, Brown, Meier, Belyk, & Liotti, 2010). It is often hard to decide when an individual sings or whistles in an unfamiliar scale, whether she is correctly producing a non-native musical pattern or is just bad at producing the native pattern. Likewise, while musical cultures differ in the complexity of their rhythms, a poorly performing individual might

fail to produce a native rhythm because she cannot keep the beat. Variations in the melodic or rhythmic structure of a musical performance therefore might not reliably discriminate members of one's own musical culture from members of a different culture due to the important individual differences in music performance.

A second reason why knowledge of culture-specific musical traditions might not be used to determine group membership relates to an argument that Kurzban, Tooby and Cosmides (2001) made regarding the relative usefulness of race as a cue to group membership. In contrast to modern societies, the members of prehistoric human societies had little or no means of rapid, long-distance travel. Because race differences arose over large geographical distances but not over small ones, the probability of encountering an individual from another race within neighboring social groups was very low. As a result, attention to race would not serve to distinguish in-group from out-group members over the distances in which humans encountered other human groups in the prehistoric conditions for which the human mind evolved.

Like race, musical styles typically vary to a considerable degree, but only over large geographical distances. In particular, ethnomusicologists divide the world into just seven to ten musical areas, based on the variation in rhythmic and melodic structure (Nettl, 1983). As a result, each of the musical areas covers a large geographic range comprising many different human groups. For example, the traditional music of many countries in south-eastern Europe (e.g., Bulgaria, Macedonia, Turkey) features similar complex rhythms (Bates, 2010; London, 1995; Rice, 1994) that are not found in the music of other parts of Europe. As a result, residents of one of these regions would most often encounter individuals from other groups whose songs shared the musical structure

of their own songs; they would have to travel a considerable distance before encountering a musical culture with a different rhythmic organization. Under these conditions, knowledge of culture-specific musical traditions would not be very informative concerning the groups to which unfamiliar individuals belong.

In contrast, familiarity with specific songs might arguably be a better cue to group membership. Like music styles, familiar songs are transmitted across generations only by direct social contacts in cultures lacking modern devices such as radios and audio recordings. Unlike musical styles, however, the individual songs that accompany the rituals and celebrations of one social group likely are not likely to be shared by neighboring groups who speak different dialects (and therefore would not use the same lyrics) and develop different rituals and social practices. If children selectively attend to the most reliable cue to group membership, they might selectively attend to shared knowledge of specific songs rather than of culture-specific musical styles. This is precisely the pattern of results we found in Experiments 1 to 4.

Nevertheless, our results so far are consistent with at least two other hypotheses. First, these early social preferences might simply be driven by a preference for any objects, events or patterns that are familiar (e.g., Zajonc, 1968), coupled with an associative process of affective tagging that leads individuals also to prefer other individuals who are associated with the preferred objects, events or patterns (e.g., De Houwer, Thomas, & Baeyens, 2001; Manis, Cornell, & Moore, 1974). Together, familiarity preferences and affective tagging could lead children to like individuals associated with familiar items more than individuals associated with unfamiliar ones (Olson, Banaji, Dweck, & Spelke, 2006; Olson et al., 2008).

Second, children might prefer social partners whom they perceive as more similar to themselves, and they might infer that social partners are similar if they prefer the same songs as they do (Duck, 1973; Lydon, Jamieson & Zanna, 1988; Meltzoff, 2007). If children's preferences depend either on affective tagging or on perception of similarity to the self, then their social choices might not result specifically from the evolutionary significance of shared knowledge of songs.

The experiments to be presented next test a natural prediction of the view that music modulates social preferences because the specific songs that one knows was, in ancestral environments, a reliable cue to one's group membership. If this view is correct, then shared *knowledge* of songs should be a more reliable cue to group membership than shared *preference* for songs. If two unfamiliar individuals from a society lacking records or radios discover that they share knowledge of a particular folk song, that discovery would immediately signal to both individuals that they are likely to belong to the same social group, even if one individual likes the song and the other does not. In contrast, if the two individuals hear a song that neither knows and discover that they both like the song, this discovery will be less informative about their group membership, even though it might be equally or more likely to induce processes that spread positive affect or induce a sense that the two people have similar preferences or predilections. When it comes to evaluating the social group membership of unfamiliar people, therefore, it may be much more adaptive to pay attention to cues based on shared knowledge rather than to cues based on emotional responses. In contrast, shared knowledge is not an especially likely basis for affective tagging or perception of similarity to the self. Music preferences, rather than music knowledge, provide a more likely basis for the latter processes.

The experiments presented so far confounded musical preferences with musical knowledge. In Experiments 1-4, each song was described as the *favorite* song of one target child; a description that implies both that the target child knew the song and that he liked it. If children perceive songs as markers of shared group membership, and not merely associate familiar songs and agents, they might selectively attend to information about shared knowledge, rather than shared preferences. In the next three experiments, we therefore tested separately for effects of shared song knowledge and shared song preferences on children's social choices.

In order to distinguish knowledge from familiarity, we changed our experimental method in several respects. After introducing children to the pairs of photographs used in Experiments 1 to 4, we played one song that was either familiar or unfamiliar to the participants (rather than two songs as in the previous experiments). We then indicated either that one target child knew the song whereas the other child did not (Experiment 5), that one child liked the song whereas the other child did not (Experiment 6), or that one child knew the song but disliked it, whereas the other child liked the song but did not previously know it (Experiment 7). Participants were then asked which of those two children they would rather have as a friend.

The three accounts outlined above make different predictions for these experiments. If children's preferences for agents are based on emotional responses to familiar songs that become associated with the agents, we would predict that children will prefer individuals who prefer or know familiar songs to individuals who prefer or know unfamiliar songs. Similarly, if children's social preferences are driven by inferences about the similarity between themselves and others, again we would expect children to

prefer others who share either their knowledge or their preference for songs. If, on the other hand, children specifically attend to cues to group membership, and prefer others who are potential in-group members, they might selectively attend to shared knowledge rather than to shared preferences, and prefer others who share their knowledge of songs.

Experiment 5

In Experiment 5, we tested the effects of others' knowledge of songs in guiding children's evaluation of social partners.

Method

Participants: Participants were 24 children (14 girls: mean age: 4 y 11 m; range 4 y - 6 y) who were recruited and tested at the Discovery Center of the Museum of Science in Boston, MA. An additional ten children were excluded from the final sample due to failure to recognize the familiar songs at the end of the session (see below; $n = 2$), failure to finish the experiment ($n = 4$), parental interference ($n = 1$), distraction ($n = 1$) or experimenter error ($n = 2$).

Displays: Visual displays were identical to those used in the previous experiments. The musical sequences consisted of six of the songs used in Experiment 3: three popular American children's songs and three 18th century American folk songs. Children listened to the songs through headphones.

Design and Procedure: On each of 6 trials, the experimenter introduced participants to photographs of two 5-year-old children on a computer screen and said: "This is (e.g.) Ashley, and this is (e.g.) Laura and here is a song I played for them". Then the experimenter played one of the six songs. After the song was played, the experimenter

said: “Ashley knows this song, and Laura doesn’t know this song, but she knows other songs”. Then the participant was asked: “Which one of these children would you like to be friends with?” Each participant received 6 trials with different pairs of photographs and with familiar and unfamiliar songs presented in ABBAAB order. The order of the familiar and unfamiliar songs was counterbalanced across participants. The lateral positions of the photographs associated with the knowledge of the songs were counterbalanced across trials, and the pairings of photographs to song knowledge was counterbalanced across participants.

Recognition test: Because Experiments 5 to 7 took place at a museum, we did not have any control over the family background of the participants. We therefore gave children a recognition test at the end of the session to assess whether they were familiar with the popular American children’s songs. Specifically, each child was presented with three additional pairs of songs from Experiment 3 (American children’s songs and 18th century American folk songs). After listening to each pair, the experimenter asked which of the two songs sounded familiar. Children who failed to choose the familiar song on at least two out of three trials were excluded from our sample.

Data Analysis: Percentage of choices of participants associated with the target child who knew the song (hereafter the “knowledgeable” target) were calculated for each participant, separately for trials with familiar and unfamiliar songs, and the average of these scores across children was compared using a paired-sample, two-tailed t-test. Choices of knowledgeable targets associated with familiar and unfamiliar songs were also compared to chance by planned, one-sample, two-tailed t-tests. The number of

children preferring the knowledgeable target for familiar and unfamiliar songs, respectively, was compared using Fisher's exact test.

Results

As shown in Figure 1.2a, Participants' preference for knowledgeable target children was significantly higher when the targets were described as knowing the familiar songs than when they were described as knowing the unfamiliar songs (familiar songs: $M = 63\%$, $SD = 32\%$; unfamiliar songs: $M = 36\%$, $SD = 29\%$), $t(23) = 3.2$, $p < .01$. Planned follow-up tests showed that participants marginally preferred the targets who knew the familiar songs, $t(23) = 1.9$, $p = .07$, and reliably preferred the targets who did *not* know the unfamiliar songs, $t(23) = 2.3$, $p < .05$. The proportion of participants who preferred the knowledgeable target differed significantly depending on whether the target knew familiar or unfamiliar songs, $p = .042$ (Fisher's exact test). Taken together, these results suggest that children prefer others who share their knowledge of songs, and *avoid* others who know songs that they themselves do not know.

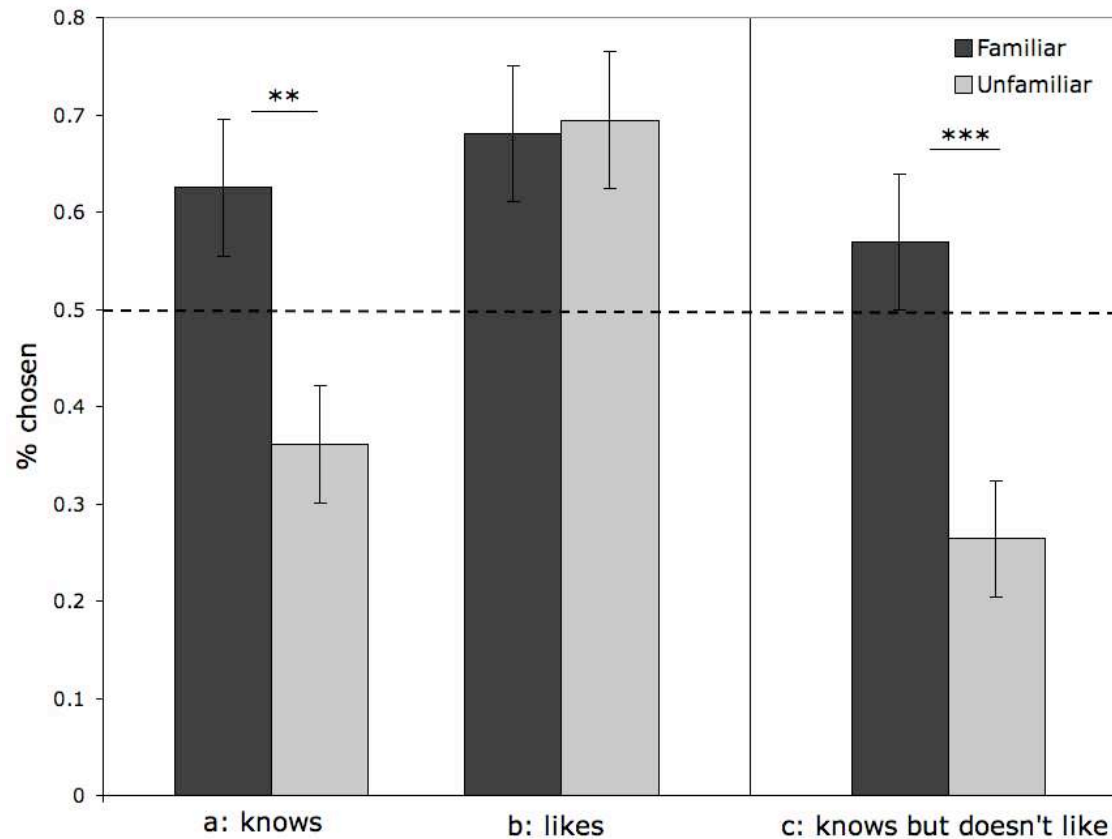


Figure 1.2. Results of Experiments 5-7. Mean choices of the social partner (a) who knows familiar and unfamiliar songs, respectively, in Experiment 5, (b) who likes familiar and unfamiliar songs, respectively, in Experiment 6, and (c) who knows but does not like familiar and unfamiliar songs, respectively, in Experiment 7. Error bars represent standard errors (** = $p < .01$, *** = $p < .001$).

Discussion

The results of Experiment 5 provide evidence that children's choice of a knowledgeable target child depends on the nature of the song that the target knows. When one of two target characters is described as knowing a song that is unfamiliar to the child, children express a preference for the target who does *not* know the song. In

contrast, when one of two target characters is described as knowing a song that the child herself knows, children tend non-significantly to prefer that target. Together, these two tendencies produce a robust preference for other children who share children's own state of knowledge regarding a song, be it knowledge or ignorance.

These findings suggest that children use knowledge of familiar vs. unfamiliar songs to modulate their social preferences, but they are open to an alternative interpretation. Children themselves may prefer familiar songs to unfamiliar songs, and they might simply avoid individuals who are positively associated with musical material that they themselves do not prefer. This possibility is addressed in Experiment 6. Specifically, we tested whether the effects we observed in Experiment 5 are specific to the described state of knowledge of each target child, or whether the effects would also obtain when we do not describe target children's song knowledge but their song preferences.

Experiment 6

In Experiment 6, we tested children's social preferences for other children who expressed preferences for familiar and unfamiliar songs, using the method of Experiment 5.

Method

The method was the same as in Experiment 5 except as follows. Participants were 24 children (11 girls: mean age: 5 y 1 m; range 4 y 1 m - 5 y 11 m). An additional 10 children were excluded from the final sample due to failure to recognize the familiar songs at the end of the session ($n = 4$), failure to finish the experiment ($n = 3$), distraction

($n = 1$) or experimenter error ($n = 2$). After the experimenter introduced the two target children and played a song, she stated: “(e.g.) Ashley likes this song, and (e.g.) Laura doesn’t like this song, but she likes other songs.”

In order to assess children’s own preferences for familiar and unfamiliar songs, and to validate our stimuli, we presented an additional twenty children (9 girls: mean age: 4 y 10 m; age range: 4 y - 5 y 10 m) with the song pairs used in Experiment 3, from which the 6 songs used in the present experiment were drawn (i.e., American children’s songs and 18th century American folk songs). After listening to each pair, the experimenter asked which of the two songs the participant liked more. Participants chose familiar (Western) songs significantly more often than predicted by chance ($M = 66\%$, $SD = 33\%$), $t(19) = 2.2$, $p < .05$. Eleven participants mostly chose familiar Western songs, four participants mostly chose unfamiliar Western songs, and the other five participants had no preference ($p = .1$, binomial test).

Results and Discussion

As shown in Figure 1.2b, participants’ choices for agents who liked familiar songs and unfamiliar songs did not differ significantly (familiar songs: $M = 68\%$, $SD = 32\%$; unfamiliar songs, $M = 69\%$, $SD = 35\%$), $t(23) = 0.2$, $p > .8$. Participants preferred both the target children who liked the familiar songs $t(23) = 2.8$, $p < .02$, and the target children who liked the unfamiliar songs, $t(23) = 2.7$, $p < .02$. The proportion of participants who preferred target children who liked songs did not differ significantly depending on whether the target children liked familiar or unfamiliar songs, $p = .8$ (Fisher’s exact test).

To compare the results of Experiments 5 and 6, we analyzed participants' choices for the target who was positively associated with a song (i.e., the target who knew or liked the song) using a repeated-measures ANOVA with song familiarity as the within-subject factor and association type (knowing or liking, i.e., Experiment 5 or 6) as the between-subjects factor. We observed a significant main effect of familiarity, $F(1,46) = 4.78, p = .034$, suggesting that children associated with familiar songs were chosen more often than children associated with unfamiliar songs, as well as a significant main effect of Experiment, $F(1,46) = 7.12, p = .011$, suggesting that participants in Experiment 6 were more likely to choose the positively associated agents. Crucially, we observed a significant interaction between familiarity and Experiment, $F(1,46) = 5.91, p = .019$. The children in Experiment 6 were equally likely to choose children liking familiar and unfamiliar songs respectively, even though children at this age prefer familiar songs over unfamiliar songs. In contrast, while children in Experiment 5 rejected children who knew unfamiliar songs, and tended to choose children who knew familiar songs, suggesting that shared song knowledge, not shared song preferences, drives children's social choices.

To probe this finding further, we conducted a final experiment in which we pitted song preferences against song knowledge. Given the findings of Experiments 5 and 6, we expected children to weight song knowledge over song preferences in selecting other children as friends.

Experiment 7

In this experiment, we tested the relative impact of shared knowledge and liking on children's evaluation of social partners. After being introduced to two potential social

partners and listening to a song, participants were told that one of the children knew the song, but did not like it, whereas the other child did not know the song, but after listening to it, liked it. Participants were then asked whom they would rather have as a friend. If children pay more attention to emotional responses to music, then, based on the results of Experiment 6, they should prefer others who like songs, regardless of their familiarity with the songs. As a result, we should not see a difference in participants' choices of agents associated with familiar and unfamiliar songs. If, on the other hand, children selectively pay attention to knowledge of songs, then, based on the results of Experiment 5, we would expect to see a difference between their choices between familiar and unfamiliar songs.

Method

The method was the same as Experiment 5 and 6 except as follows. Participants were 24 children (12 girls: mean age: 5 y; range 4 y- 5 y 11 m). An additional eight children were excluded from the final sample due to failure to recognize the familiar songs at the end of the session ($n = 4$), failure to finish the experiment ($n = 1$), distraction ($n = 2$) or experimenter error ($n = 1$). On each trial, the experimenter introduced and named two target children, played the song, and then stated: “(e.g.) Ashley knows this song, but doesn’t like it. Laura doesn’t know this song, but after hearing it, she likes it.”

Results and Discussion

As shown in Figure 1.2c, participants' choices for the knowledgeable agents associated with familiar songs and unfamiliar songs significantly differed (familiar songs: $M = 57\%$, $SD = 33\%$; unfamiliar songs: $M = 26\%$, $SD = 29\%$), $t(23) = 5.1$, $p < .001$. The proportion of choices for children who knew but did not like the familiar target songs did

not differ significantly from that expected by chance, $t(23) = 1.0, p > .3$. In contrast, participants chose children who knew but did not like unfamiliar target songs at frequencies significantly *below* chance, $t(23) = 3.9, p < .005$. The proportion of participants who preferred knowledgeable children differed significantly depending on whether the children were associated with familiar or unfamiliar songs, $p = .017$ (Fisher's exact test). Thus, even though participants preferred target children who liked familiar and unfamiliar songs equally well, when knowledge was pitted against preference, participants' choices depended on the familiarity of the songs.

The combined results of Experiments 5-7 suggest that, in general, children prefer agents who 'like' songs, regardless of whether the songs are familiar or not, perhaps because individuals who like things are perceived as more positive than individuals who do not like things. Crucially, however, children's social preferences are markedly different when they receive information about their potential partner's knowledge of songs that are familiar or unfamiliar to the children themselves. Children tended to choose targets who know familiar songs, even if this required that they reject the target who liked these songs. In contrast, when liking of a song and *ignorance* of an unfamiliar song coincided, children significantly chose the corresponding target. Together, these results suggest that children's social preferences based on song familiarity are driven by children's inferences about shared knowledge, an important cue to group membership.

General Discussion

The present research explores the nature of early social preferences by investigating the role of music in guiding children's evaluation of potential social partners. The

findings of Experiments 1 to 4 suggest that the favorite songs of potential social partners affect children's evaluation of these partners, but that some aspects of musical structure are more privileged than others in terms of guiding social preferences. Social effects of music are only observed when the songs differ in terms of familiarity with specific songs, or when the songs differ in terms of the conformity to the universal musical rules. In striking contrast, we observed no clear effects of familiarity with the general musical conventions of our participants' own culture. Even though children judge that unfamiliar songs that follow the conventions of their own culture are more like the music they know, they show no preference for target children associated with these songs.

In Experiments 5 to 7, we investigated how expressed preferences for, and knowledge of, songs affected children's social choices. Results revealed two separate effects on children's choices. First, children generally like others who like songs, regardless of whether the songs are familiar or not. Second, children choose to be friends with others who know familiar songs, and reject others who know unfamiliar songs, despite their contrasting music preferences.

At first sight, it might seem surprising that culture-specific musical styles had no influence on children's social preferences, given that cultural groups have been distinguished by their music throughout history. However, from an evolutionary perspective, we suggest that familiarity with a specific song is a more useful cue to group membership than familiarity with a general musical style, for two reasons. First, individual songs can be recognized even when they are imperfectly performed, for example when a person sings out of tune or misses the beat. In contrast, it is often difficult to distinguish the musical style of an unfamiliar piece that is performed

imperfectly. Given the variance in people's music performance skills, especially in singing (Pfordresher & Brown, 2007; Pfordresher, Brown, Meier, Belyk, & Liotti, 2010), the familiarity or unfamiliarity of a musical style will not as readily distinguish less musically competent performers from one's own group from performers belonging to other social groups.

Second, in the prehistoric societies for which our minds evolved, individuals were unlikely to encounter other agents from a culture with a different musical convention, simply because the typical range of an early human was most likely too small to encounter different musical cultures. In contrast, even neighboring groups likely differed in their repertoire of specific songs, as do human groups living in preindustrial societies today. Therefore, similarly to the relative usefulness for language and race in previous discussions of the evolutionary origins of social cues (Kurzban et al., 2001), mastery of specific songs may have been a good cue to group membership prior to the introduction of rapid, long-distance travel; in contrast, mastery of a musical style may provide less relevant social group information in ancient societies.

Another remarkable aspect of our results is the dissociation in how emotional preferences and shared knowledge affected children's social choices. Children prefer other children who like songs, irrespective of whether or not these songs are familiar. In contrast, children prefer other children who know familiar songs, and reject other children who know unfamiliar songs. This outcome is surprising, because we found that children in the population we tested themselves preferred the familiar songs. Despite their own preferences, children evidently had no preference for other children emotionally associated with these songs. Although it is possible that children do prefer others who

share these musical preferences, and that this tendency would appear if children were tested with other methods, the present findings suggest that shared song knowledge trumps shared song preferences in guiding children's social choices.

This finding, in turn, offers a different perspective on the common observation, and documented finding, that in adolescence, friendship choices are influenced by musical tastes (e.g., North & Hargreaves, 1999). In previous studies, as in Experiment 3 of the present series, shared musical preferences and shared musical knowledge are confounded: adolescents with the same musical tastes both know and like the same songs. It would be interesting, therefore, to probe the separate effects of preferences and knowledge in this population, through studies using methods like that of Experiment 7.

The dissociation that we find between the roles of emotional preferences and shared knowledge might reflect the considerable fitness benefits associated with the ability to recognize in-group and out-group members. In at least three respects, song knowledge is more informative than song preferences about an individual's past social history. First, in ordinary social encounters, knowledge of songs can be assessed objectively (e.g., by asking an individual to sing along with the song) and is, therefore, verifiable. In contrast, one can just pretend to like a song, without any possibility of verification. Second, musical preferences are necessarily less informative about group membership than musical knowledge, because different members of one group may and often do have different emotional responses to the same songs, and members of different groups may have similar emotional responses to those songs. Third, although some preferences endure over long time periods, other preferences are subject to change. Over the course of childhood, in particular, musical preferences may change significantly. In

contrast, knowledge tends to be more enduring. Knowledge of specific songs, in particular, may endure throughout the life of an individual. Song knowledge therefore is a more stable source of information about a person's social history.

In one respect, knowledge of songs is a less reliable a marker of group membership than is knowledge of certain other culture-specific cues including accent and complex social rituals, because songs are more easily acquired. It is difficult to imitate an accent or a dialect, but one can easily learn a song that is specific to a social group. However, even if it is easy to learn new songs, the acquisition of such knowledge requires social interactions with other group members; as a result, individuals who share such knowledge are most likely either in-group members themselves or accepted associates of ingroup members, reducing the risk of dishonest signals about group membership.

Shared knowledge of songs thus seems to be a relatively reliable cue to group membership. Moreover, given that music is an important part of every cultural group, it may present a privileged type of knowledge whose evolutionary function might be precisely to foster in-group cohesion, and to serve as an in-group identification. Our results show that even young children are remarkably selective in the cues they use in social choices, and might selectively attend to the most reliable cues to identify and selectively interact with in-group members, which, in turn, might allow them later in life to participate in the complex social organization that is unique to human societies.

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Part 2: How music influences infants' visual preferences for the singers

Abstract

Exposure to music starts prior to birth, yet little is known about social effects of music in infancy. Here, we ask whether and how music affects five-month-olds' visual preferences for singers. We presented infants ($N=72$) with two people singing different songs. Subsequently, both singers were presented silently, and infants' visual preferences were measured. Infants looked at people who previously sang familiar songs over those who sang unfamiliar songs. When both songs were unfamiliar, infants did not prefer singers of songs following Western melodic structure over singers of songs violating it, although previous research has shown that they are sensitive to these differences. These findings suggest that some properties of music start to influence attention to individuals in selective ways in infancy, and might contribute to the development of social preferences.

Introduction

Humans are an exquisitely social species whose fitness depends on successfully negotiating the complexities of human societies. Accordingly, even young babies are remarkably attuned to social signals and use them to selectively allocate their attention to potential social partners. One domain that plays an important role in all aspects of our social life is music. However, despite its important social functions, little is known about when or how music begins to modulate children's social categories, inferences, or preferences.

Human adults spend much of their lives interacting with other humans in a variety of activities that range from the cooperative to the antagonistic. To negotiate successfully their environment, they have, therefore, to process social signals reliably and to react adaptively. A growing literature suggests that such abilities can be traced back to early infancy. Even young infants seem to be remarkably selective in whom they preferentially attend to (and whom they preferentially ignore), based on various physical and behavioral traits. Infants preferentially attend to characters who help others over characters who hinder others (Hamlin, Wynn, & Bloom, 2010), to people who speak in an infant-directed style as opposed to adult-directed style (Schachner & Hannon, 2011), to people who speak their native language with a native accent, as opposed to those who speak in a foreign language or accent (Kinzler, Dupoux & Spelke, 2007), and to faces of a familiar race and gender (Bar-Haim, Ziv, Lamy, & Hodes, 2006; Kelly, et al., 2005; Quinn, Yahr, Kuhn, Slater, & Pascalis, 2002). Although the social motives that drive these looking preferences can be debated (e.g., Kinzler & Spelke, 2011), the looking

patterns themselves likely predispose infants to engage with and learn about people who are friendly or belong to the infant's social group.

While early social competencies have been studied in a variety of domains, there is one domain that has received surprisingly little attention: music. The gap in our knowledge is surprising, because exposure to music starts prior to birth (Kisilevsky, Hains, Jacquet, Granier-Deferre & Lecanuet, 2004), and music plays an important social role in every known human culture. Specific traditional songs accompany most of the events that bring together members of a social group. Because the melodic and rhythmic structure of music varies across cultures, different cultural groups also have different musical traditions (Cross, 2001), making musical style as well as specific songs a potential cue to social group membership.

Consistent with these social roles, a person's expressed preferences for specific songs and musical genres influence adolescents' and adults' expressed social preferences for that person (e.g., Epstein, 1994; Johnstone & Katz, 1957; Lonsdale & North, 2009; Rentfrow & Gosling, 2006). One's own musical preferences, moreover, are arguably an important determinant of one's ethnic and social identity (Adorno, 1941; Shepherd, 1977). Indeed, adults make accurate inferences about others' personalities, values, and even their social and ethnic characteristics solely based on their expressed musical preferences (North & Hargreaves, 1999; Rentfrow & Gosling, 2003; 2006; 2007; Rentfrow, McDonald & Oldmeadow; 2009; Tekman & Hortacsu, 2002).

Recent evidence suggests that music modulates social preferences even in young children in surprisingly selective ways. Soley & Spelke (in review) presented five-year-old children with two target children whose favorite songs differed in terms of familiarity

and/or musical structure, and asked participants which child they would prefer as a friend. Children preferred other children whose favorite songs were familiar to them. However, when unfamiliar songs were presented that differed in whether they adhered to the culture-specific musical style of the children's culture, no social preferences resulted. Further studies revealed that children's social preferences were selectively driven by shared *knowledge* of songs rather than shared *preferences* for songs: children chose social partners who knew songs that were familiar to them, and rejected social partners who knew songs that were unfamiliar to them, regardless of whether or not the target children liked these songs.

Based on these findings, Soley & Spelke (in review) hypothesized that when children choose among social partners, they selectively attend to the cues to group membership that were most informative for distinguishing between the members of neighboring social groups in ancestral human environments (Kurzban Tooby & Cosmides, 2001). Prior to the arrival of modern media, shared cultural knowledge such as rituals, folk tales and songs could only be acquired only through a chain of shared social experiences. As a result, two individuals who share knowledge of the same songs are more likely to be members of the same social group.

In contrast, culture-specific musical traditions may have been less valid cues to group membership in ancient human societies. Although the melodic and rhythmic structures used in music differ to a considerable degree in cultures that are very distant (e.g., Indian vs. Western scales; Western vs. Balkan rhythms), they show few or no differences across pre-industrial, neighboring groups within a single geographic region (Nettl, 1983). Prior to the development of technology permitting rapid, long-distance

travel, therefore, the general musical and melodic structures used by neighboring groups likely did not differ, but the specific songs that group members invented and passed to their children likely varied. Even if two social groups share a given musical style, it is extremely unlikely that members of the two groups would invent the same specific melody independently. When two people from a preindustrial society are found to know the same song, therefore, it is highly likely that a chain of social transmission links them.

A second reason why song familiarity, rather than musical style, might be more informative about social group membership concerns the variability in human musical performance. Many humans are notoriously bad at producing music, especially when singing is involved (Pfordresher & Brown, 2007; Pfordresher, Brown, Meier, Belyk, & Liotti, 2010). As a result, when one hears an unfamiliar person singing a discordant melody or unusual rhythm, it might be hard to decide whether the individual is singing a tune from an unfamiliar musical tradition, or is simply a bad singer of songs from one's own musical culture. For both these reasons, shared knowledge of songs may have been a more reliable cue to shared group-membership.

In the experiments presented below, we begin to investigate the developmental origins of the predisposition to choose social partners based on shared musical knowledge. However, both the methods available for studying five-month-old infants, and the developmental limitations of infants' music perception, constrain the questions we can ask about early social competencies. We discuss these issues in turn.

Social preferences in early infancy typically are assessed by measuring infants' visual preferences between two human faces or social agents (e.g., Kelly et al., 2005; Hamlin et al., 2010). Such methods indicate how infants allocate attention to different

potential social partners, but they do not support conclusions concerning the social nature of these preferences. In the experiments below, we ask whether infants preferentially attend to a person whose singing reveals information that guides the social choices of older children and adults. If such evidence is found, then future research, using more explicitly social measures (e.g., Kinzler et al., 2007; Meltzoff, 1995) could investigate whether this predisposition comes to modulate the social choices of older infants (e.g., Kinzler, Dupoux & Spelke, in press).

In addition to the limits on the methods available for assessing social preferences in young infants, there are important constraints on the questions that we can ask that derive from infants' limited sensitivity to, and knowledge of, the music of their culture. Consider, for example, the development of perception of rhythm. A hallmark of mature, implicit knowledge of culture-specific musical patterns is that adults process native musical rhythms better than non-native musical rhythms. In their first year of life, in contrast, infants process native and non-native rhythms equally well (Hannon & Trehub, 2005a; 2005b). At around six months of age, infants prefer the rhythms of their own culture to rhythms of other cultures (Soley & Hannon, 2010), suggesting that young infants have some knowledge about music of their native culture. Nevertheless, infants' sensitivity to cultural differences in musical structure likely is far lower than that of adults.

In the case of melodic structure, past research has shown that infants process native and non-native melodies equally well (for reviews, see Hannon & Trainor, 2007; Trainor, 2005; Trehub, 2003). To the extent that processing difficulties signal knowledge of culture-specific musical conventions, these results raise the possibility that young

infants might not discriminate between native and non-native melodies. There are, however, some aspects of musical structure that constrain infants' perception of rhythm and pitch even prior to the acquisition of culture-specific knowledge (Bergeson & Trehub, 2006; Cohen, Thorpe, & Trehub, 1987; Hannon, Soley, & Levine, 2011; Soley & Hannon, 2010; Trehub, Thorpe & Trainor, 1990). In particular, infants are better at detecting changes within a *tonal* Western melody, with notes drawn from one of the diatonic scales and successive tones forming simple frequency ratios, compared to changes within an *atonal* melody featuring more complex frequency ratios between the successive tones (Cohen, Thorpe, & Trehub, 1987; Trehub, Thorpe & Trainor, 1990). Moreover, simple interval ratios occur more frequently in both Western nursery songs and other Western music (Cohen, Thorpe, & Trehub, 1987; Roberts, & Shaw, 1984), presumably because simple intervals intrinsically sound more pleasant. Thus, irrespective of how developed young infants' implicit knowledge about Western musical conventions is, they might find (tonal) melodies following the characteristics of Western melodic structure more pleasing than (atonal) melodies that violate it.

In the research presented below, therefore, we investigate the effects of song familiarity and tonal structure on 5-month-old infants' visual preferences for human singers. Building on a paradigm that has revealed attentional preferences in five-month-old infants for speakers of their native language (Kinzler et al., 2007), we ask whether infants preferentially attend to people who previously produced familiar songs over people who previously produced unfamiliar songs. We also ask whether infants show similar preferences between people who produce familiar songs that differ in terms of the songs' pitch structure (tonal vs. atonal). Based on our findings with older children and

our ecological analysis of the role of song familiarity in distinguishing social groups in ancient times, we hypothesize visual preferences to be driven by familiarity of songs, but not by tonality of the songs when both songs are unfamiliar.

A final constraint on our experimental method stems from the need to control for unintended, confounding social signals from the people who appeared in our displays. In any experiment using social or musical displays, unintended differences between the behaviors of the actors can be difficult to eliminate. For example, our initial attempts to record singers of familiar and unfamiliar songs revealed that those who sing familiar songs tend to differ subtly in their manner and facial expressions from those who sing novel ones. To control for these and other potentially confounding differences, we presented infants with the same videotaped social events in all conditions, and we tested infants' preferences, across all the experiments, with physically identical social displays (after Kinzler et al., 2007). To this end, all the singing displays presented visual images of two singers who both were recorded as they sang tonal versions of the familiar song. The soundtracks of these displays were then eliminated and replaced by dubbed versions of the three songs so as to create six different audio-visual displays (two singers who were each accompanied by a song that was familiar and tonal, unfamiliar and tonal, or unfamiliar and atonal). At the time looking preferences were recorded, moreover, all infants viewed exactly the same pair of silent events. In these ways, we assure that only the differences in the previously presented song structure could modulate infants' looking preferences.

In Experiment 1, we presented infants with videotaped events of two women singing “Twinkle Twinkle Little Star” (familiar) or an unfamiliar atonal song with the

same lyrics and tempo. This song was selected based on an informal survey with parents (N=30) whose children participated in unrelated experiments in our laboratory. “Twinkle Twinkle Little Star” was the song most frequently reported by parents to be familiar to their infants. Following the familiarization phase, we measured infants' looking times to the two people who previously sang these songs.

Experiment 2 was identical to Experiment 1, except that the singer of the unfamiliar song sang the lyrics to "Twinkle, twinkle" with a melody that followed all the rhythmic and tonal conventions of Western music. This experiment tested, therefore, whether familiarity with specific songs is sufficient to modulate infants' subsequent preferences for the singers, when the melodic and rhythmic structures of the two songs are equally natural and familiar.

Finally, in Experiment 3, we investigated the role of melodic structure in guiding infants' visual preferences for the singers. Both singers sang the lyrics to "Twinkle, twinkle" with unfamiliar melodies, either tonal or atonal. This experiment tested, therefore, whether differences in melodic structure are sufficient to modulate infants' looking preferences between the people who previously sang to them.

Experiment 1

In Experiment 1, infants were familiarized with videotaped events of two women, each singing the lyrics to "Twinkle, twinkle" with either the familiar melody or with notes in the same tempo, arranged into a sequence that was both unfamiliar and atonal. Before and after hearing these songs, infants were presented with the same two women, side by side and silent, and their looking times to each woman were measured and

compared. We tested whether infants would look longer, in the final preference test, at the woman who previously sang a song that was familiar to them.

Method

Participants. Twenty-four infants (12 girls; mean age: 5 months, 22 days; range 5 months, 16 days - 5 months 29 days) were retained for the final analysis. An additional 9 infants were tested but were excluded from the final sample because of equipment failure (1), baseline preference ($> 80\%$ looking at one singer on the initial silent baseline trial) (5), distraction (2), or because the parents indicated that their child was not familiar with “Twinkle Twinkle Little Star” (1). In all experiments reported here, infants in the final sample came from predominantly English-speaking families; further, according to parental report, they were healthy, full term and had no history of hearing impairment. Testing took place at the Laboratory for Developmental Studies at Harvard University.

Displays. The familiar melody consisted of the first four measures of “Twinkle Twinkle Little Star” (see Figure 2.1a). The unfamiliar song was created by changing the melodic structure of “Twinkle Twinkle Little Star” to produce an atonal melody that violated Western tonal structure (i.e., the tones in the melody were not drawn from a single scale) with some of the successive tone intervals creating highly complex frequency ratios (see Figure 2.1b). To maximize the infants’ interest, the musical excerpts in this and all other experiments were sung on three different pitch levels, yielding six musical sequences in total. The frequencies of the starting notes were 220 Hz, 261 Hz, and 293 Hz for the familiar songs, and 261 Hz, 329 Hz, and 349 Hz for the unfamiliar songs. The rhythmic structure, tempo, length and the lyrics were identical in all songs across all experiments.

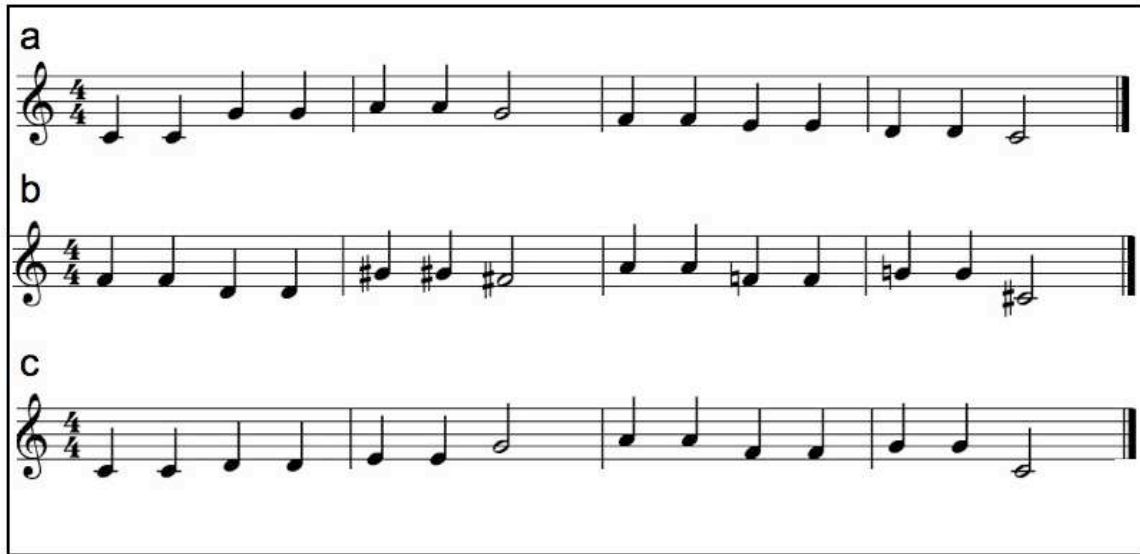


Figure 2.1. The melodies used in the experiment, presented in musical notation. (a) Original, familiar melody (“Twinkle Twinkle Little Star”). (b) Atonal, unfamiliar melody. (c) Tonal, unfamiliar melody.

Accompanying the music were video displays (60 x 78 cm) of two actors singing. Two female actors were videotaped while singing the first four measures of “Twinkle Twinkle Little Star”. Then an experienced female singer watched these videos and sang the songs at the three pitch levels mentioned above, in synchrony with the actors’ lip movements. The singer was instructed to sing all songs in a similar, infant-directed style. The resulting recordings were used as the sound tracks of all the videos. Additional visual stimuli consisted of videotaped events of each actor smiling silently.

All stimuli were prepared as QuickTime movies. We created a total of 12 familiarization films of singing (6 with each woman singing each of the musical excerpts); these movies lasted for about 13 s each. An additional two movies showed the

same two actors silently smiling for about 22 s. Example displays are shown in Figure 2.2.

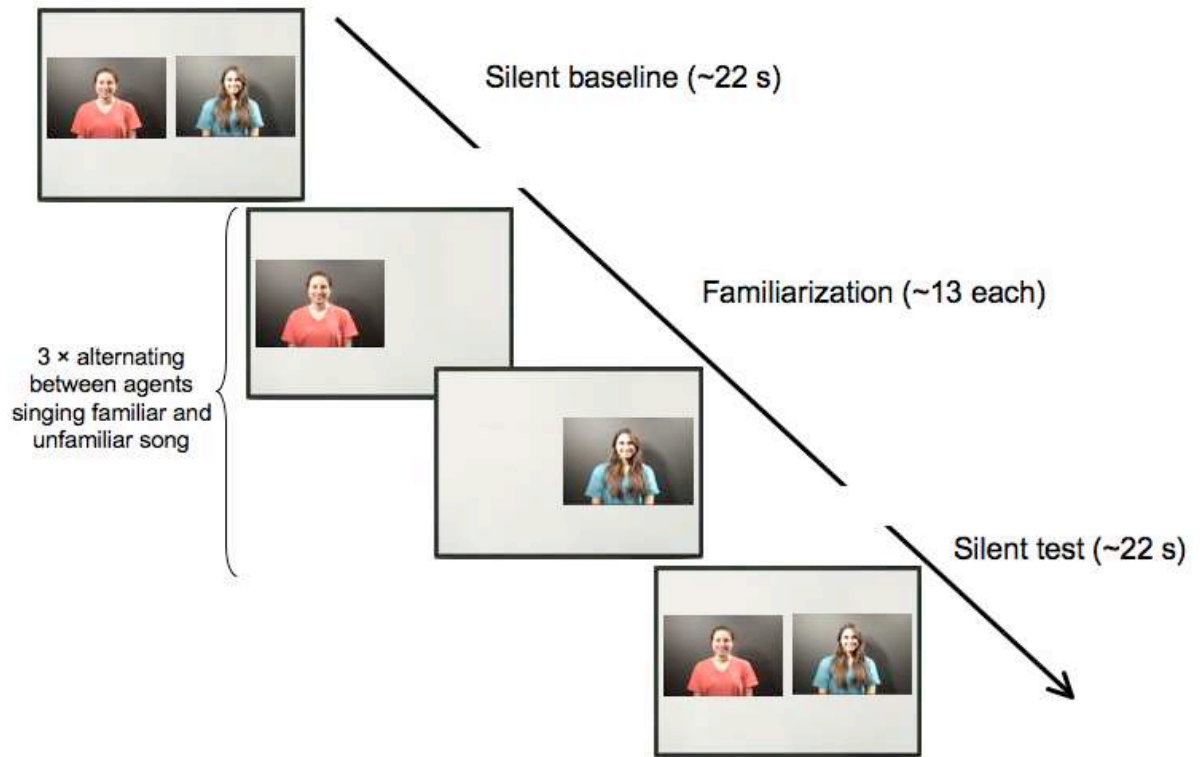


Figure 2.2. Trial structure of the experiments. Each experiment started with a silent baseline trial, where two women appeared side-by-side, silently smiling for approximately 22 s. Then each woman appeared one by one in an alternating order, each singing a different song, for three trials. After these familiarization trials, the two women appeared again side-by-side, silently smiling for approximately 22 s.

Design. For each infant, one actor sang the familiar song and the other actor sang the unfamiliar song throughout the experiment; the pairings of actors to songs was counterbalanced across infants. Similarly, the order of events (familiar song first vs. unfamiliar song first) and the lateral position of each actor on the screen (left vs. right of

center) were kept constant across trials, but both of these were orthogonally counterbalanced across infants, creating a 2 (actor/music pairing) by 2 (order) by 2 (lateral position) design, with 2 infants tested in each condition.

Procedure. Infants were seated on their parents' lap in a dimly lit testing room with a projection screen located approximately 1m in front of the infant. Parents listened to classical music through noise-canceling headphones (Sony, MDR-MC6). Because only the soundtracks distinguished the displays presented to infants, the use of headphones ensured that parents were blind to the experimental conditions.

The experiment started by presenting two women side-by-side, silently smiling to the infant for approximately 22 s. Infants' looking time to each of the singers were measured. Following this baseline test, infants were presented with six alternating films of the two women, one singing a familiar song and one an unfamiliar one. The sound of the videos was presented via a centrally located, hidden loudspeaker (Altec, ACS 90). In order to maximize infants' interest, the pitch level of each song progressed from low to high over the trials. After the movies had been presented, infants were presented with a test trial identical to the baseline trial, and their looking times to each actor were recorded. The infants' behavior was monitored using a digital infrared video camera (Sony DCR-HC32) located below the screen and focused on the infant's face.

Data analysis. An experimenter (blind to the condition) measured looking times to each actor by performing off-line frame-by-frame coding using Supercoder v.1.5 (Holich, 2005). The average of percentage of looking times to the actor associated with the familiar song was calculated for the silent baseline, the singing familiarization, and the silent test trials. Twenty-five percent of the videos of each experiment were randomly

selected and coded by a second experienced experimenter to ensure inter-observer reliability. Across experiments, the coders' agreement was $r = 0.99$, $p < .0001$.

Infants' looking preferences were coded separately on the baseline trials, the familiarization trials (during which the dubbed singing movies were presented), and the test trials, by measuring in each case the proportion of time spent looking at the actress who was designated, for that infant, as the singer of the familiar song. Following the procedures of Kinzler et al. (2007), infants were excluded from the study and replaced if they devoted more than 80% of their looking time to one of the actresses on the baseline trial. In the final sample, looking preferences for the actress who sang the familiar song were compared to chance levels (50%) by two-tailed t-tests, performed on each of the three sessions of the experiment (baseline, familiarization, and test). In addition, we assessed the change in the proportion of time spent looking at the singer of the familiar song between baseline and test.

Results

Figure 2.3a shows the results of Experiment 1. During the baseline and familiarization phases of this experiment, infants looked equally at the two actresses ($t(23) = .75$, $p = .46$, $t(23) = .35$, $p = .73$, respectively). During the final test phase, in contrast, infants looked longer at the actress who previously sang the familiar song ($M = 58.1\%$, $t(23) = 2.35$, $p < .05$). Nineteen of the 24 infants looked longer at the singer of the familiar song during this test trial ($p = .007$, binomial test).

The preference for the actress whose song was familiar increased significantly from the baseline trial to the test trial, $t(23) = 2.6$, $p < .02$. Again, 19 of 24 infants

increased their looking, from baseline to test, to the singer of the familiar song ($p = .007$, binomial test).

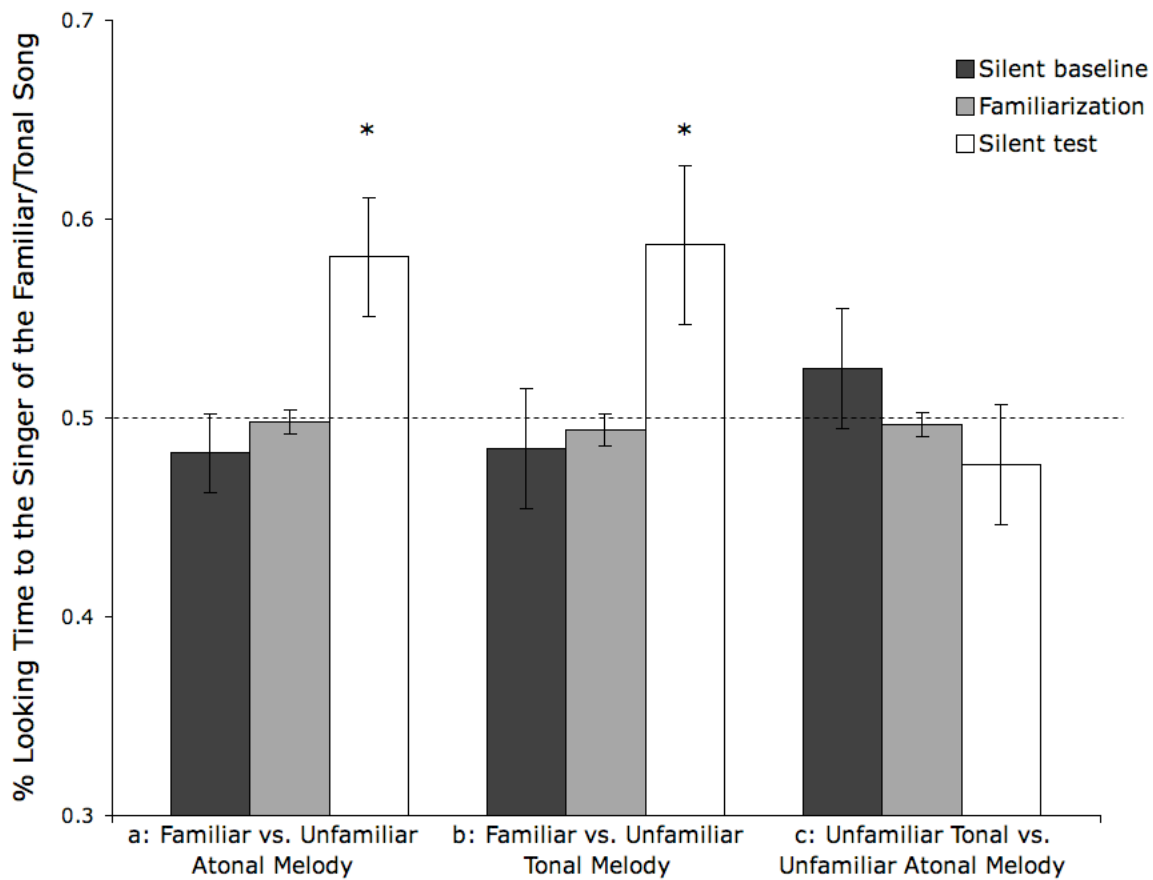


Figure 2.3. Infants' looking preferences in (a) Experiment 1, (b) Experiment 2, and (c) Experiment 3. Error bars represent SEM. * $p < .05$.

Discussion

In Experiment 1, five-month-old infants showed a visual preference for an actress who previously sang a familiar song, compared to an actress who previously sang an unfamiliar song with an atonal melody. Crucially, the looking time measurements were taken after music had been stopped; as a result, infants developed a looking preference for the person who produced the music, and not just for the music itself.

While these results suggest that music can influence infants' attention towards singers already at five months of age, it does not reveal the properties of music that exert this effect, because the songs in Experiment 1 differed both in terms of how familiar they were to the infants, and in terms of their overall melodic structure. The next two experiments test separately for each of these effects.

Experiment 2

Experiment 2 further investigated the role of song familiarity in modulating five-month-old infants' subsequent visual preferences for their singers. We used the same method as in Experiment 1, except for the unfamiliar song. The familiar song from Experiment 1 now was paired with a second song that also conformed to the characteristics of Western melodic structure. Crucially, however, one of the songs was familiar to the infants, whereas the other was not.

Method

Participants. Twenty-four infants (15 girls; mean age = 5 months, 23 days; range = 5 months, 15 days - 6 months) were retained for the final analysis. An additional 13 infants were excluded from the final sample due to experimenter error or equipment failure (2), baseline preference (5), fussiness (2) or because the parents indicated that their child was not familiar with "Twinkle Twinkle Little Star" (4).

Displays. The familiar melody consisted of the first four measures of "Twinkle Twinkle Little Star." The unfamiliar melody was created by changing the location of the notes of "Twinkle Twinkle Little Star" but keeping both the frequency ratios between the successive notes similar to those in the original melody, and by arranging the notes so as

to present an equally natural melodic contour and a song that matched the familiar song both in tempo and in lyrics (see Figure 2.1c). As a result, the unfamiliar song conformed to the conventions of Western music. We generated three versions of each excerpt as described above (the frequencies of the starting notes were 220 Hz, 261 Hz, and 293 Hz for both the familiar songs and the unfamiliar songs), and used them as sound tracks to the movies, along with the three versions of the natural, familiar song from Experiment 1.

Results

Figure 2.3b shows the results of Experiment 2. During the baseline and familiarization phases of this experiment, infants looked equally at the two actresses ($t(23) = .57, p = .57, t(23) = .77, p = .45$, respectively). During the final test phase, in contrast, infants looked longer at the actress who previously sang the familiar song ($M = 58.7\%$, $t(23) = 2.38, p < .05$. In all, 18 of 24 infants looked longer at the singer of the familiar song during this test trial ($p = .02$, binomial test).

The preference for the actress whose song was familiar increased significantly from the baseline trial to the test trial, $t(23) = 2.4, p < .05$. Nineteen of 24 infants increased their looking, from baseline to test, to the singer of the familiar song ($p = .007$, binomial test).

Two further analyses compared infants' test trial looking preferences in Experiments 1 and 2. First, a one-way ANOVA, comparing infants' preferences for the singer of the familiar song during the silent test trials in Experiments 1 and 2, revealed no significant difference between the experiments, $F(1, 46) = .01, p = .906$. Second, a 2 (Experiment) by 2 (Preference trial: Baseline vs. Test) ANOVA compared the change in infants' preferences for the singer of the familiar song, from baseline to test. This analysis

revealed a highly significant increase, across the two experiments, in infants' preference for the actress who sang the familiar song, $F(1,46) = 12.2$, $p < .001$. There was no main effect of Experiment or interaction of Experiment with Preference trial (both $F_s(1, 46) < 1$).

Discussion

In both Experiments 1 and 2, infants preferred to look at the actor associated with the familiar song, irrespective of whether the unfamiliar song violated or conformed to culture-specific and culture-universal melodic constraints.

While these findings suggest that song familiarity may be sufficient to elicit preferences for individuals in infants, it is possible that some properties of the familiar song might make it more preferable, and might have contributed to the current pattern of findings as well. Specifically, the familiar and unfamiliar tonal melodies were matched on various dimensions such as the length, rhythmic structure, number of pitch classes, pitch range, and the frequency ratios between the successive tones. However, these melodies differed in terms of the number of directional contour changes: the familiar melody had one directional contour change, the unfamiliar tonal melody had three directional changes, and the unfamiliar atonal melody had six directional changes. One might, therefore, argue that infants might find the familiar melody easier to process and thus more pleasant than the unfamiliar tonal melodies, because it has fewer contour changes.

In Experiment 3, we will test the effects of melodic structure on infants' preferences more directly by pitting two unfamiliar songs against each other: the unfamiliar songs of Experiment 1 (atonal) and Experiment 2 (Western tonal). If melodic

structure influences infants' preferences for the singers, we would expect infants to increase their propensity to look at the singer of the tonal song, because it is constructed according to a culturally familiar and simpler melodic structure.

Experiment 3

Experiment 3 used the same method as in Experiments 1 and 2. However, both songs were unfamiliar to the infants, one conforming to the characteristics of Western melodic structure, and the other violating it.

Method

Participants. Twenty-four infants (12 girls, mean age = 5 months, 24 days; range = 5 months, 16 days - 6 months) were retained for the final analysis. An additional 7 infants were excluded from the final sample due to equipment failure (1), baseline preference (2), fussiness or distraction (2) or because the parents indicated that their child was not familiar with "Twinkle Twinkle Little Star" (2).

Displays, design, procedure, and analyses. These were the same as in Experiments 1 and 2, except for the sound tracks to the films, which consisted of the three tonal and three atonal unfamiliar melodies of Experiments 2 and 1, respectively, sung to the lyrics and tempo of "Twinkle, twinkle".

Results

Figure 2.3c shows the results of Experiment 3. During the baseline and familiarization phases of this experiment, infants looked equally at the two actresses ($t(23) = .93, p = .36, t(23) = .86, p = .4$, respectively). During the final test phase infants again looked no longer at the actress who previously sang the tonal song, relative to the

actress who previously sang the atonal, unfamiliar song ($M = 47.7\%$), $t(23) < 1$, n.s. Ten of 24 infants looked longer at the singer of the tonal song during this test trial (n.s., binomial test).

The preference for the actress whose song was tonal showed no increase from the baseline trial to the test trial, $t(23) < 1$. Eleven of 24 infants increased their looking, from baseline to test, to the singer of the tonal song ($p = .84$, binomial test).

Further analyses compared the looking patterns of the infants in Experiment 3 to those in Experiment 1. A one-way ANOVA comparing the preferences of infants during silent test trials revealed a significant difference between the preferences of infants for the singer of a tonal song in the two experiments, $F(1, 46) = 5.7, p < .05$. A two-way ANOVA comparing the pretest and post-test preferences across these two experiments revealed a significant interaction of Experiment by Trial (baseline vs. test), $F(1, 46) = 9.3, p < .01$ and no other effects. By both measures, infants showed a greater preference for the actress whose previous song was tonal when the song was also familiar than when it was not.

Analyses with the same structure compared the looking patterns of infants in Experiment 3 to those in Experiment 2. A one-way ANOVA comparing preferences of infants during the silent test trials across Experiments 2 and 3 revealed a significant difference in their preference for the singer of the unfamiliar tonal song, $F(1, 46) = 5.9, p < .05$. Moreover, a two-way ANOVA comparing the pretest and post-test preferences across these two experiments revealed a significant interaction of Experiment by Trial, $F(1, 46) = 8.3, p < .01$ and no other effects. By all measures, song familiarity (tested in

Experiment 2) had a greater effect on infants' subsequent visual preferences than did melodic structure (tested in Experiment 3).

Discussion

In Experiment 3, infants showed no looking preference for a person who previously sang a tonal unfamiliar song, relative to a person who previously sang an atonal song. This finding suggests that familiarity with specific songs might play a greater role than familiarity with musical structure in guiding infants' attention toward social agents than familiarity with musical structure.

However, as discussed in Experiment 2, it is possible that the difference between the numbers of directional contour changes in both experiments might have contributed to infants' preferences as well. At first sight, the results of Experiment 3 seem to argue against this possibility, because the unfamiliar tonal melody had three directional contour changes, while the atonal one had six; yet infants did not exhibit any preferences. Still, if melodic preferences are influenced by the number of contour changes, it is possible that infants can discriminate one contour change from the three contour changes, but not three from six changes. We will come back to this issue in the general discussion.

The negative findings of Experiment 3 also contrast with the findings of experiments that focus on infants' perception of, and preferences for, music directly. As discussed in the introduction, it is unclear whether infants at this age already have an implicit knowledge about the Western scale structure (for a review, see Trainor, 2005).

Nevertheless, such infants are sensitive to the contrast between tonal and atonal melodies used in Experiment 3 (Cohen, Thorpe, & Trehub, 1987; Trehub, Thorpe & Trainor, 1990). Despite their sensitivity to musical structure, infants did not use these

structures to modulate their subsequent visual preferences for the singers. The results of Experiment 3 therefore suggest that infants selectively respond to song familiarity.

General Discussion

Humans are exquisitely sensitive to social cues when choosing among social partners. In the domain of music, even young children's choices of social partners are selectively based on cues to group-membership such as shared knowledge of songs. Here, we asked whether infants' visual preferences for individuals draw on the same cues that are associated with group-membership later in life. We show that five-month-old infants exhibit a visual preference for agents who previously sang a familiar song over agents who sang an unfamiliar (tonal or atonal) song. In contrast, when infants were presented with two singers who both produced unfamiliar songs, they showed no preference between them, even though one song followed the characteristic structure of Western melodies, whereas the other did not and was atonal. Together, these results suggest that song familiarity rather than a more abstract familiarity with the musical structure might have a privileged status in guiding infants' subsequent visual preferences for the singers.

Our results are in line with Soley & Spelke's (in review) finding that young children choose social partners selectively based on shared knowledge of songs, and not on melodic structure (but see below for alternative explanations). At first sight, this finding is puzzling, because children clearly are sensitive to melodic structure and revealed this sensitivity when they were asked about the songs directly. However, this pattern of findings fits with the ecological context in which social preferences likely evolved (Kurzban et al., 2001), insofar as song familiarity potentially is a more reliable

cue than melodic structure to the social group distinctions that humans encountered prior to the development either of musical recording and transmission devices or of rapid, long-distance travel.

Our results fit with this view, by revealing that the preference for singers of familiar songs extends back to human infancy. Infants preferentially attend to singers of familiar songs. In contrast, they show no such preference for singers of unfamiliar songs with Western tonal structure. The attentional preferences of infants therefore accord with the more explicitly social preferences of older children (Soley & Spelke, in review).

Before accepting these conclusions, it is important to keep in mind some caveats. First, we cannot conclude that five-month-old infants share the social preferences that are prominent in five-year-old children. The methods used in this and in previous experiments reveal how infants allocate attention to human agents as a function of the music they previously produced, but they do not reveal whether infants have social or affective preferences for these people. Here, we only note that infants' attentional biases are consistent with social preferences observed later in life. Further research using different methods is needed to determine whether these visual preferences reflect social processes.

Second, our experiments do not reveal whether the effects we observed reflect differences in infants' weighting of different types of musical distinctions or in their perception of those distinctions. In particular, we do not know whether infants failed to attend to people who previously sang tonal rather than atonal unfamiliar melodies because they do not use tonal structure to modulate their preferences or because they failed sufficiently to detect the relevant tonal structure in the present displays.

Knowledge of familiar songs might be robust in infancy, whereas knowledge of tonality might be more fragile, as the research reviewed in the introduction suggests (Cohen, Thorpe, & Trehub, 1987; Trehub, Thorpe & Trainor, 1990).

If indeed infants are more sensitive to familiarity than to melodic structure, that pattern could be an effect of the greater informativeness of song familiarity on social group relations. Paying attention to appropriate individuals is clearly crucial even early in infancy, and might confer important benefits, including learning the most relevant knowledge (Csibra & Gergely, 2006) and getting the best care possible. Greater sensitivity to familiar songs than to tonality or to culture-specific traditions might reflect the relative adaptiveness of these cues for choosing among social partners. Because we did not measure infants' sensitivity to the present song structures directly, however, our experiments do not disentangle the perceptual and social effects of music on infants' attention to singers.

Third, as discussed in detail in Experiments 2 and 3, the number of directional contour changes in the melodies might have contributed to the pattern of results we observed. While the familiar melody had one contour change, the unfamiliar tonal melody had three and the unfamiliar atonal melody had six contour changes. As result, it is possible to explain the pattern of results reported here by positing that (i) musical complexity and preferences are driven by the number of contour changes, (ii) infants (implicitly) count the number of contour changes, and (iii) three contour changes are more easily discriminated from one contour change than from six contour changes. Therefore, further research comparing melodies with identical number of contour

changes is needed to be able to firmly conclude that infants' preferences are driven purely by the familiarity of the songs.

Finally, there is an alternative explanation to the current findings, holding that infants may be responding to the lyric-tune congruity rather than melodic familiarity. Specifically, in our experiments, in an effort to make the songs maximally comparable on all possible dimensions except the melodic structure, we used same lyrics paired with each melody. However, because infants have presumably heard the familiar tune song along with its lyrics numerous times, they might find it less pleasant or strange to hear same lyrics along with unfamiliar melodies. Therefore, it is possible that infants' preferences are driven by this congruity between the lyrics and the tune rather than the familiarity of the tune itself.

However, this possibility is ruled out by further studies using the same methods and actors as the current experiments, but instrumental versions of the same songs used here. In one study, infants were presented with two women who clapped in synchrony with the same familiar and unfamiliar tonal melodies as used in Experiment 2. While infants paid equal attention to both women during the silent baseline and the familiarization trials, at test, they looked significantly longer at the woman who had previously clapped in synchrony with the familiar song (Soley, Hannon, & Spelke, in prep). Given that these experiments did not involve any lyrics at all, the results cannot be driven by a melody-lyrics mismatch, and must be due to song familiarity or one of the melodic factors discussed above. Thus, in the current experiments, infants' attention is not likely to be driven by the melody-lyrics congruity either.

In summary, our results provide evidence that music influences young infants' visual preferences for individuals and infants might selectively attend to certain musical cues that are associated with group membership later in life. This early influence of music on social preferences suggests that even young infants might be remarkably attuned to highly relevant social cues.

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Part 3: Children's use of race and gender to attribute shared musical knowledge and preferences

Abstract

Young children show preferences for individuals based on various social cues including gender, age, race and language, but the cognitive bases and implications of children's social distinctions are not clear. Are children selective in the properties they use to infer that two individuals belong to the same group, and do they make inferences about individual group members based on some or all of these properties? Here, we approach these questions by asking if children attribute shared musical knowledge or shared music preferences to individuals of the same race or gender. Concerning shared knowledge, we show that four-year-old children generalize knowledge across individuals of the same gender, but not race, whereas five-year-old children show the reversed pattern, attributing shared knowledge to individuals of the same race but not gender. Further, we show that children of both ages generalize preferences based on gender, and five-year-old children also attribute shared preferences based on race. Thus, the social categories of race and gender come to be connected to two markers of shared culture over the preschool years.

Introduction

From early in life, humans are flexible in the ways in which they divide their social world into categories, including categories that have a biological basis (e.g., gender), categories that depend on cultural learning (e.g., preferences for sports teams), and categories based on what appear to be ad-hoc cues (e.g., the color of T-shirts; Bigler, Jones, & Lobliner, 1997). Social categories serve as the basis for rapid inferences about socially relevant traits of members of a given category, and, when faced with a member of a category, adaptive behavior is contingent on these inferences.

While young children and even infants use a wide variety of cues like race, gender, language to categorize their social world and make adaptive social choices based on these cues, it is not known what inferences these categories license and, crucially, whether they license inferences about shared group membership. However, throughout history, humans have lived in groups of mutually interacting and cooperating individuals who collectively competed with other groups. As a result, individuals needed to reliably identify members and non-members of their social group. Here, we ask which social cues young children use to infer the group membership of an individual, and whether these inferences change over time.

Early sensitivity to social categories

Children, from very early on, show social preferences based on a variety of cues including age, gender, accent, race, and music (Finkelstein, & Haskins, 1983; French,

1987; Kinzler, Dupoux, & Spelke, 2007; Martin, Fabes, Evans & Wyman, 1999; Soley & Spelke, in review). Two of the major, perceptually salient, social categories by which adults organize their social world are race and gender (Brewer, 1988; Fiske, 1998). Sensitivity to these categories is observed early in life, as children prefer individuals of their own gender and race (Aboud, 1988; Kircher & Furby, 1971; Kowalski & Lo, 2001; Martin, Fabes, Evans, & Wyman, 1999). Whereas positive dispositions towards own-gender individuals appear as early as two years of age, and are quite robust from very early on (Maccoby & Jacklin, 1978; LaFreniere, Strayer, & Gauthier, 1984; Shutts, Banaji, & Spelke, 2010), studies are not conclusive on own-race preferences in children younger than five years of age (Aboud, 2003; Aboud, Mendelson, & Purdy, 2003; Aboud & Skerry, 1984; Kinzler & Spelke, 2011; Kircher & Furby, 1971; Shutts, Banaji, & Spelke, 2010; Stevenson & Stevenson, 1960). For instance, while 10-month-old infants and 2.5- year-old children show no explicit preferences for own-race individuals on a variety of social measures such as a preference for interacting with own-race individuals rather than other-race individuals (e.g., taking a toy from or giving a toy to an own-race individual), five-year-old children prefer own-race children when presented with two children differing in race and asked whom they would rather have as their friend (Kinzler & Spelke, 2011). Further, while pre-school children assign more positive attributes to individuals of their own gender (Albert & Porter, 1983; Yee & Brown, 1994), they attribute positive characteristics to own-race only in cases where the race has high status (Aboud, 1988; Bigler & Liben, 1993). Similarly, while three-year-old children prefer novel activities (e.g., playing with a *spoodle*) that are ostensibly preferred by children of

their own gender, children's preferences for novel objects endorsed by same-race children are not consistent (Shutts, Banaji, & Spelke, 2011).

Even if there is a consensus that, at five years of age, social preferences can be driven by race and gender, the implications of these preferences are unclear. On the one hand, children might consider same-race or same-gender individuals as part of their own social group as defined above. On the other hand, their early preferences might be driven by a number of factors that become linked to group membership only later in life, such as emotional biases, or judgments of similarity between themselves and potential social partners.

A new assay of social group membership: inferences of shared cultural knowledge

How can we assess whether children infer shared group-membership based on various social categories? Recent evidence suggests a simple test: children should infer that two individuals of the same social category have shared knowledge of cultural traditions such as songs, tales and cultural practices only if they infer that the two individuals also belong to the same social group.

Specifically, Soley & Spelke (in review) argued that, before the introduction of modern means of distributing knowledge (e.g., books, recordings, television and the internet), shared knowledge could only be transmitted by means of direct social interactions. Consequently, if one individual encountered another, unfamiliar individual who demonstrated knowledge of the melody and lyrics of a song or a culture-specific social practice that was known to the first individual, it was highly likely that a chain of

direct social contacts linked the two individuals. Hence, from an evolutionary perspective, shared knowledge might reliably identify members of one's own group.

In line with this view, Soley & Spelke (in review) showed that children are selective in terms of the cues they pay attention to when making social choices. Children both prefer others who know songs they themselves know, and avoid others who know songs they do not know. In contrast, children show no tendency to prefer others who like the songs they themselves like, or to avoid others whose song preferences differ from their own. Hence, children's preferences for other agents seem to be driven selectively by a shared state of cultural knowledge. Soley and Spelke argued that children's attention to shared cultural knowledge might reflect its status as a relatively reliable marker of shared group membership, and that even young children selectively attend to those cues that signal group membership most reliably. In contrast, musical preferences might have a variety of sources and, therefore, do not reliably indicate group membership.

Here, we take advantage of these results, and use them as a test for whether children infer from observing that two individuals are members of the same social category that the two individuals are members of the same social group. For example, if they conclude that two members of the same race are part of the same social group, they should infer that the two individuals share cultural knowledge.

Note that Soley & Spelke's (in review) results do not guarantee that such an inference will take place. Although they argued that two individuals share socially transmitted cultural knowledge only if they are part of the same group, it does not follow that any two members of the same group will share a particular piece of cultural

knowledge. However, humans might have evolved a bias to infer that individuals of the same group share cultural knowledge even if it is possible that some group members might not share it. As a result, if results show that participants infer shared cultural knowledge based on shared social categories, then they must have concluded that the corresponding individuals belong to the same group, and we can use shared cultural knowledge inferences as a test of whether participants infer shared group membership based on shared social categories. We will test this issue below.

Specifically, we ask whether children infer that individuals share knowledge of songs based on the observation that they have the same race or gender. We ask whether such inferences are more prominent for one of these social categories than for the other, and whether these inferences change as a function of age. In Experiment 1, four and five year-old children were introduced to a song and a photograph of a child; they were informed that the child *knew* the song. Then they were introduced to photographs of two other children; one was of a different social category than the first child, while the other shared the social category with the first child. The categories we tested were *race* and *gender*. Participants were asked which of the latter children knew the same song as the first child. In Experiment 2, we tested whether the pattern of inferences observed in Experiment 1 was specific to shared cultural knowledge, or whether other traits such as shared preferences for music would be generalized across these categories in similar ways. We tested shared preferences because previous work suggests that they may not be reliable cues to group membership. Experiment 2 was thus identical to Experiment 1, except that the first child was described as liking a song (as opposed to knowing it in Experiment 1).

Experiment 1

Experiment 1 tested whether children would draw inferences about shared group membership of two individuals of the same race or gender. We further asked whether these inferences would differ across these two social categories and whether children's tendency to make these inferences would change with age (between four and five years).

Method

Participants. Thirty-two four-year-old children (16 girls: mean age: 4 y 6 m; range 4 y - 4 y 11 m) and thirty-two five-year-old children (16 girls: mean age: 5 y 6 m; range 5 y - 5 y 11 m) participated in the experiment. Two additional children were eliminated from the final sample due to failure to finish the experiment ($n = 1$) or parental interference ($n = 1$). All children were white, except for two children in the gender condition (one Asian and one Black). Children were recruited from the greater Boston area and tested in the Laboratory for Developmental Studies at Harvard University or at the Discovery Center of the Museum of Science in Boston, MA.

Displays. Visual displays consisted of 16 triads of photographs of young children. Each triad contained three pictures of children that were matched based on adult ratings on attractiveness, positiveness, friendliness and their estimations of age of the target child (see Figure 3.1 for an example display). In each triad, two photographs belonged to the same social category (i.e., gender or race), and the other photograph was from a different category.⁵ Auditory accompaniments consisted of 8 computer-generated songs, presented

⁵ The roles of the test pictures in each test pair (i.e., matching vs. non-matching) were not counterbalanced across participants. Rather, we matched the test photographs on dimensions that might have affected the participants' choices. To confirm that participants' choices were not influenced by these extraneous factors, for each picture, we acquired adult ratings ($N = 18$) on dimensions including attractiveness, positiveness,

without lyrics. Four of the songs were Western popular children's songs (e.g., "Mary Had a Little lamb", "Row Row Row Your Boat"), and four were unfamiliar American folksongs from the 18th century. All songs were created as MIDI files using the same instruments on GarageBand (Apple Inc., Cupertino, CA).



Figure 3.1. Example displays.

friendliness, intelligence, likelihood of knowing many songs, likelihood of enjoying music, and estimated age. For each test pair and dimension, we calculated the difference between adults' ratings of the matching photograph and the non-matching photograph; as described in the main results, we also calculated the percentage of children who chose the matching photograph over the non-matching one. For each dimension, we then computed the correlation across test pictures between the probability of choosing the matching photograph and the difference in adult ratings. We found no significant correlations with two exceptions. First, in the race-preference condition (Experiment 2), we found a *negative* correlation between rated likelihood of knowing many songs and the children's choices, $F(1,6) = 9.4$, $p = 0.022$, $R^2 = -0.611$. Second, also in the race-preference condition (Experiment 2), we found a *negative* correlation between the rated likelihood of enjoying music and the children's choices, $F(1,6) = 23$, $p = 0.003$, $R^2 = -0.793$.

Design and Procedure

Gender condition. In the gender condition participants could make inferences about shared knowledge, based on the (potential) social cue of gender. Participants were first shown a photograph of a young male or female White child on a computer screen (hereafter the sample photograph). As the photograph was shown, a song was played, and participants were told that the child on the picture knew the song. Following this, two additional photographs of White children differing in gender were shown on the screen side by side (hereafter the test photographs) while the sample photograph remained visible on the screen. Participants were asked: “One of these children also knows this song, which one do you think knows it?”

Each participant received 8 trials with different sets of photographs and songs. For half of the trials, the sample photograph showed a female child; for the other half, it showed a male child. The pairing of gender of the sample photograph to songs (familiar vs. unfamiliar) as well as the lateral positions of the same-gender test photographs was counterbalanced across trials. The order of the familiar and unfamiliar songs as well as the order of gender of the sample picture were counterbalanced across participants within each gender. Further, for half of the female participants, the first sample child associated with a familiar song was female; for the remaining female participants, it was male. Stimulus presentation was similarly counterbalanced for male participants.

Participants listened to the songs through the speakers of a laptop computer in the laboratory, and through headphones in the museum.

Race condition. The race condition was identical to the gender condition, except that, on each trial, all three children in the photographs (sample and test) were of the

same gender, and differed in terms of race (black vs. white). For half of the trials, the children in all three photographs were male; for the remaining trials, they were all female. The pairing of race and gender of the sample photograph to songs (familiar vs. unfamiliar) as well as the lateral positions of the same-race test photographs was counterbalanced across trials. The order of the familiar and unfamiliar songs and the order of race of the sample picture were counterbalanced across participants within each gender. The order of whether the familiar song was first associated with a photograph of same-race sample child as the participant was also counterbalanced across participants. Further, for half of the female participants, the first sample child associated with a familiar song was female; for the remaining female participants, it was male. Stimulus presentation was similarly counterbalanced for male participants.

The race and gender conditions present, therefore, an asymmetry. In the race conditions, half of the trials involved children who matched the participants in gender and half did not; in the gender conditions, in contrast, all the trials involved children who matched the participant in race. To evaluate the effect of whether or not the gender of the photographs matched the participants' gender, we present further analyses and data in Appendix A1-A4.

Results

To compare the results of the Race and Gender conditions, we analyzed participants' choices for the same-category photograph using an ANOVA with age (four vs. five years) and type of category (gender or race) as between-subjects factors and familiarity (whether the song was familiar or unfamiliar to the participant) and match (whether the gender or the race of the sample photograph matched the participant's race

or gender) as within-subject factors. We observed a significant interaction between category and age, $F(1,60) = 8.11, p = .006$. Further, we obtained a main effect of match $F(1,60) = 11.87, p = .001$, and a significant interaction between match and category, $F(1,60) = 4.94, p = .03$. No other significant main effects or interactions were observed (see Figures 3.2a and 3.2b).

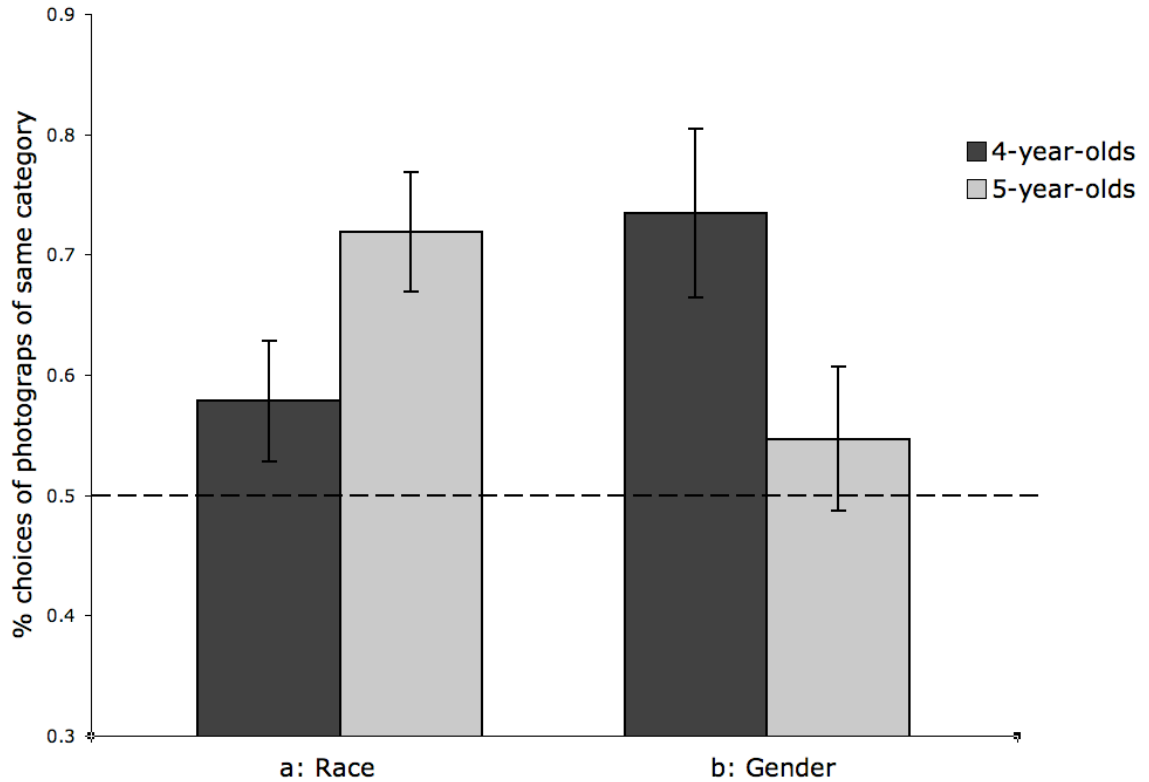


Figure 3.2. Results of Experiment 1. Overall mean choices associated (a) with same race photographs, and (b) with same gender photographs when children are asked to draw inferences about shared knowledge. Error bars represent standard errors.

Given the significant interaction between category and age, two additional one-way ANOVAs were conducted for each social category with age as a between-subjects factor. These analyses reflect that children's choices of same-category photographs

tended to increase between ages four and five in the race condition, $F(30) = 3.5, p = .07$, whereas they tended to *decrease* in the gender condition, $F(30) = 3.8, p = .06$. The significant interaction between match and category suggests that across both age groups, and across all trials with familiar and unfamiliar songs, the participants were more likely to attribute shared knowledge to members of the same social category, when their own gender matched the sample child's gender, $t(31) = 3.52, p = .001$. A similar tendency was observed in the race condition, but this effect was not significant, $t(31) = 1.05, p = .3, ns$.

In the race condition, four-year-old children's tendency to choose photographs with children of the same race as on the sample photograph did not differ from chance ($M = 58\%, SD = 21\%$), $t(15) = 1.46, p = .164$ (see Figure 3.2a). Ten participants mostly chose photographs of same-race children, whereas four mostly chose photographs of other-race children, and two had no preference ($p = .18$, binomial test).⁶ Five-year-old children chose photographs of same-race children as on the sample photograph significantly more often than expected by chance ($M = 72\%, SD = 21\%$), $t(15) = 4.13, p = .001$ (see Figure 3.2b). Fourteen participants mostly chose photographs of same-race children, whereas one mostly chose photographs of other-race children, and one had no preference ($p = .001$, binomial test).

In the gender condition, four-year-old children chose photographs of same-gender children significantly more often than expected by chance ($M = 73\%, SD = 30\%$), $t(15) = 3.14, p = .007$ (see Figure 3.2b). Ten participants mostly chose photographs of same-gender

⁶ Participants with no preference (i.e. 50%) were eliminated from the binomial analyses.

children, whereas three mostly chose photographs of other-gender children, and three had no preference ($p = .09$, binomial test). In contrast, five-year-olds' tendency to choose photographs with children of the same gender as on the sample photograph did not differ from chance ($M = 55\%$, $SD = 24\%$), $t(15) = .78$, $p = .45$ (see Figure 3.2a). Five participants mostly chose photographs of same-gender children, whereas six mostly chose photographs of other-gender children, and five had no preference ($p > .999$, binomial test).

Additional analyses of the race condition revealed no significant differences between children's performance in trials where the gender of the stimuli matched the participant's gender and in trials where the gender of the children on pictures did *not* match the participant's gender. Likewise, analyses in which the race condition was restricted to those trials where the stimulus children matched participants in gender yielded similar results to those reported above (see Appendix A1 and A2 for the details of the additional data and analyses).

Discussion

Overall, four year-old children tended to infer shared knowledge between same-gender individuals, and not between same-race individuals. In contrast, five-year-old children tended to infer shared knowledge between same-race individuals but not between same-gender individuals. The increase in children's propensity to infer shared knowledge based on race cues accords with previous research that, at this age, race is not as robust a category as gender, and that children do not show consistent social preferences based on race before the age of five (e.g., Aboud, Mendelson, & Purdy, 2003; Kinzler & Spelke, 2011; Shutts, Banaji, & Spelke, 2010). However, our

experiments leave open an alternative interpretation. Specifically, the developmental pattern in the race condition might reflect developmental changes in the children's ability to deal with the increased variability of the race condition. While this interpretation is made less plausible by previous research showing that a sensitivity to race cues emerges between the fourth and the fifth year of life, we will come back to this issue in the general discussion.

Crucially, however, and irrespective of whether or not children's sensitivity to race cues changes with age, they showed a decrease in their attributions of shared knowledge based on gender cues between the ages of four and five. At first sight, this decrease in children's propensity to infer shared knowledge based on gender is surprising. However, there are reasons to think that the category of gender is *not* a good indicator of mutually interacting social groups. Although some social groups are segregated by gender (e.g., hunting groups, sports teams), most enduring groups such as tribes and families necessarily contain both genders for the purposes of reproduction. Hence, it is possible that children realize that many social groups, like families and preschool classrooms, contain both genders, and that knowledge tends to be shared across members of these groups as they communicate with each other. In contrast, they might be more likely to realize that race is a potential cue to group membership, simply because the social groups they encounter, like families and playgroups, are more likely to be fully or partially racially homogenous. Thus, as children gain experience with social interactions, they might adjust the kinds of inferences they make based on these cues. This, in turn, might explain why they stop attributing shared knowledge based on shared gender, while they start attributing shared knowledge based on shared race. If so, these results suggest

that children are selective in what kind of inferences they make based on the social category and these inferences change as they acquire more experience with these categories.

Experiment 2

Experiment 2 tested the specificity of the results obtained in Experiment 1. Rather than exploring children's propensity to infer shared knowledge across individuals, Experiment 2 targeted their propensity to infer shared musical preferences across individuals because, as mentioned in the introduction, evolutionary considerations suggest that shared cultural knowledge is a much more reliable cue to social group membership than shared emotional responses (i.e., liking a song); after all, for most of our species' existence, cultural knowledge was exclusively transmitted from one individual to another through a chain of direct social interactions, whereas preferences may always have had many different sources. Further, previous research has shown that children are less likely to make social choices based on musical preferences (Soley & Spelke, in review). As in Experiment 1, we ask whether these inferences would change as a function of children's age (4 vs. 5 years) and of the social category over which they were asked to generalize (gender vs. race).

Method

Participants. Thirty-two four-year-old children (16 girls: mean age: 4 y 4 m; range 4 y - 4 y 11 m) and thirty-two five-year-old children (16 girls: mean age: 5 y 6 m; range 5 y - 5 y 11 m) participated in the experiment. Three additional children were eliminated from the final sample due to failure to finish the experiment ($n = 1$), distraction ($n = 1$), or

developmental delays (according to parental report; $n = 1$). All children were white, except two children in the gender condition (both Asian).

Displays. The displays were identical to those used in Experiment 1.

Design and Procedure. Both the gender and the race condition were identical to those in Experiment 1, with one crucial exception: instead of making inferences about shared musical knowledge, participants had to make inferences about shared musical preferences. That is, participants were told that the child on the sample photograph *liked* the song that was played, and were asked which of the children on the test photograph was more likely to like the song as well.

Results

To compare the results of Race and Gender conditions, we analyzed participants' choices for the same-category photograph using an ANOVA with age (four vs. five years) and type of social category (gender or race) as the between-subjects factors and familiarity (whether the song on a given trial was familiar or unfamiliar) and match (whether the gender or the race of the sample photograph on a given trial matched the participant's own race or gender) as the within-subject factors. We observed no significant main effects or interactions with the exception of a marginally significant main effect of match, $F(1,60) = 3.78, p = .057$. Children's choices of same-category photograph did not differ between ages four and five in the race condition, $F(1,30) = 1.18, p = .29$, nor the gender condition, $F(1,30) < .1, p = .934$ (see Figure 3.3a and b). These results suggest that children's inferences about shared preferences do not differ depending on the category on which such inferences are based, nor as a function of age. Unlike Experiment 1, the match between the social category to which the sample child

and the participants belonged did not have any effects on the participants' attributions of shared preferences among members of the same social category.

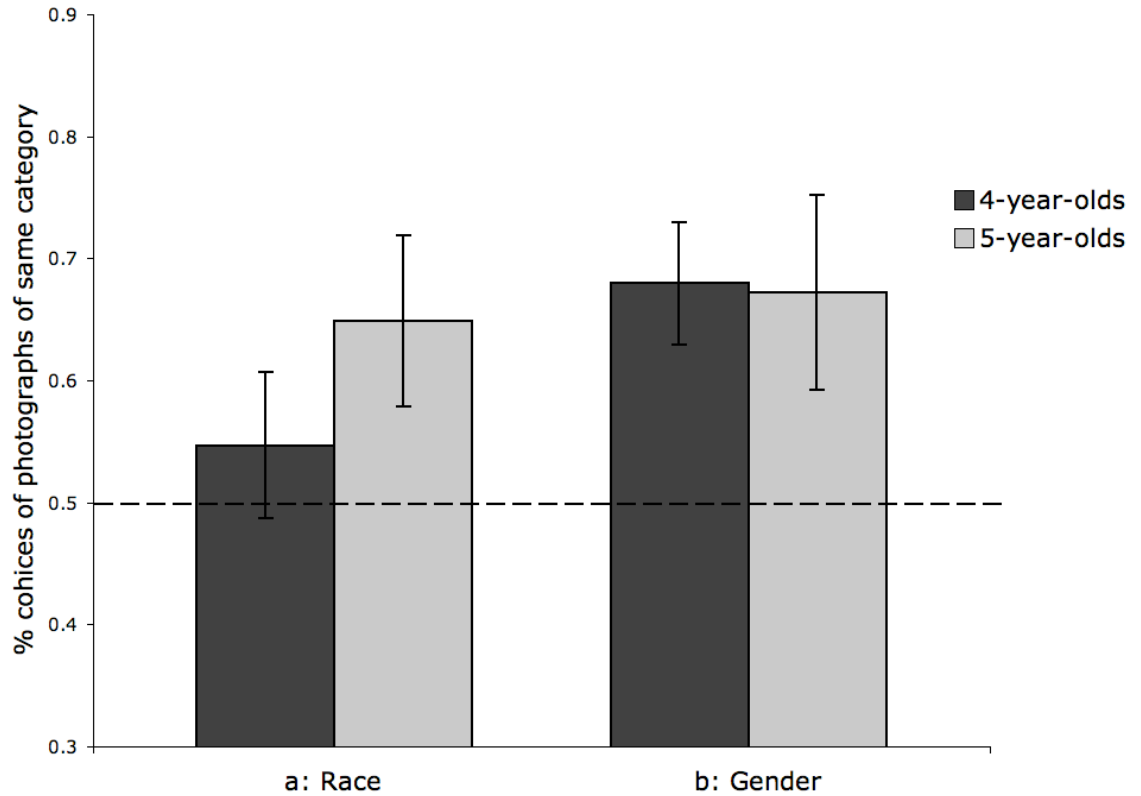


Figure 3.3. Results of Experiment 2. Overall mean choices associated (a) with same race photographs, and (b) with same gender photographs when children are asked to draw inferences about shared preferences. Error bars represent standard errors.

In the race condition, four-year-olds' tendency to choose photographs with children of the same race as on the sample photograph did not differ from chance ($M = 55\%$, $SD = 25\%$), $t(15) = .74$, $p = .471$ (see Figure 3.3b). Six participants mostly chose photographs of same-race children, whereas six mostly chose photographs of other-race children and four had no preference ($p > .999$, binomial test). Five-year-olds chose photographs of same-race children significantly more often than expected by chance ($M =$

65%, $SD = 28\%$), $t(15) = 2.16$, $p = .047$ (see Figure 3b). Nine participants mostly chose photographs of same-race children, whereas three mostly chose photographs of other-race children and four had no preference ($p = .15$, binomial test).

In the gender condition, four-year-olds chose photographs of same-gender children significantly more often than expected by chance ($M = 68\%$, $SD = 19\%$), $t(15) = 3.72$, $p = .002$ (see Figure 3.3a). Eleven participants mostly chose photographs of same-gender children, whereas one mostly chose photographs of other-gender children, and four had no preference ($p = .006$, binomial test). Five-year-olds also chose photographs of same-gender children significantly more often than expected by chance ($M = 67\%$, $SD = 32\%$), $t(15) = 2.15$, $p = .048$ (see Figure 3.3a). Ten participants mostly chose photographs of same-gender children, whereas four mostly chose photographs of other-gender children and two had no preference ($p = .18$, binomial test).

As in Experiment 1, the designs of the race and gender conditions present an asymmetry, because all stimuli in the gender conditions showed children of the same race, in the race conditions, half of the stimuli showed female children and half male. Therefore, we further analyzed the results of Experiment 2, by including only the subset of trials of the race conditions where the stimulus children matched the participants in gender. As in Experiment 1, these analyses yielded similar results to those reported above (see A1-A4 for the details of these additional data and analyses).

We conducted two additional ANOVAs with type of social category (gender vs. race) and inference type (knowledge vs. preference) as the between-subjects factors and familiarity (whether the song on a given trial was familiar or unfamiliar) and match (whether the sample picture matched the participant's own gender or race on a given

trial) as the within subject factors to test the effects of these factors and the interactions separately for each age group. In four-year-old children, we found a significant main effect of social category, $F(1,60) = 5.07, p = .028$, a marginal effect of match, $F(1,60) = 3.68, p = .06$, and a marginal interaction between category and familiarity, $F(1,60) = 3.55, p = .065$, but no other significant main effects or interactions. In five year old children, we found a marginal interaction between category and inference type, $F(1,60) = 3.34, p = .073$, a significant main effect of match, $F(1,60) = 12.06, p = .001$, and a significant interaction between match and category, $F(1,60) = 5.1, p = .028$. No other significant main effects or interactions were observed.

Appendix A3 provides additional analyses of those trials in which the sample picture matched the participants in both gender and race. These data represent four trials per participant in the gender conditions, and two trials in the race conditions. Hence, while the pattern of the results still hold, the comparisons become non-significant due to larger error bars.

Thus, while four-year-old children tended to infer that members of the same gender share both knowledge and preferences, they did not draw any of these inferences based on race. As mentioned above, however, the difference in the design of the race and gender conditions does not allow us to conclude whether this difference might be due to the difference in four-year-olds' sensitivity to race and gender as social categories, or whether it is rather due to the more complex design of the race conditions.

Unsurprisingly, our findings also suggest that, both age groups were more likely to attribute shared knowledge and preferences to individuals belonging to the same social category when the sample photograph matched their own social category membership.

However, among those trials of the race conditions where the race of the sample photograph matched the participants' race, the gender of the photographs did *not* match the participants' gender in half of the trials. Nevertheless, we did not observe an overall interaction with match and category, suggesting that the factor 'match' affected children's choices similarly in the race and the gender conditions, despite this difference in the designs. Possibly, children realize that only one of the categories is relevant for the experiment, because the test stimuli differ in that category; as a result, they might focus on the relevant category, and be less sensitive to the irrelevant category.

In five-year-olds, the significant interaction between match and category suggests that participants were more likely to attribute shared knowledge and preferences to members of the same social category as the sample child when their own gender matched the sample child's gender, $t(31) = 3.4, p = .002$, but no such effect was observed in the race category, $t(31) = 1.16, p = .256$. Crucially, the marginal interaction between inference type and category suggests that five year-olds tend to infer shared knowledge more among same-race individuals than among same-gender individuals, whereas they tend to infer shared preferences more among-same-gender individuals than among shared-race individuals.

Finally, we conducted an omnibus ANOVA with age (four vs. five), social category (gender vs. race) and inference type (knowledge vs. preference) as the between-subjects factors, and familiarity (whether the song on a given trial was familiar or unfamiliar) and match (whether the gender or the race of the sample photograph on a given trial matched the participants' gender or race) as the within-subject factors. We found a significant main effect of match, $F(1,120) = 13.97, p < .001$, a significant

interaction between match and category, $F(1,120) = 5.03, p = .027$, between age and category, $F(1,120) = 5.49, p = .021$, and a marginal three-way interaction between familiarity, age and category, $F(1,120) = 2.83, p = .095$. The three-way interaction between age, category and inference type, $F(1,120) = 2.40, p = .124$, and all other main effects and interactions were non-significant. Identical analyses including only the subset of trials of the race conditions where the stimulus children matched the participants in gender yielded similar results with the exception of the interaction between familiarity, match and inference type (see Appendix A2.3. and A.4 for the details of these analyses).

Discussion

The results of Experiment 2 suggest that children's inferences about shared preferences do not change as a function of social category nor as a function of age. However, separate analyses showed that, while older children did infer shared preferences among members of the same-race category, this effect failed to reach significance in younger children. In the case of gender, both age groups inferred shared preferences between the members of the same gender category.

Confirming earlier work (e.g., Aboud, Mendelson, & Purdy, 2003; Kinzler & Spelke, 2011; Shutts, Banaji, & Spelke, 2010), the overall analyses suggest that younger children are not as sensitive to race as a social category as they are to gender (though, as mentioned above, such a conclusion cannot be drawn based on our experiments alone). Not surprisingly, children's generalizations of knowledge and preferences are affected by whether the sample child matched the social category they themselves belong to, especially in the case of gender and in the older age group. However, this bias to favor own race or own gender individuals was additive (with the exception of an interaction

between match and category), and the pattern of results outlined above held true after including this factor in the analyses.

Moreover, while five year-olds tended to infer shared knowledge only among same-race individuals, no such pattern was observed for their inferences of shared preferences, which they inferred among both same-race and same-gender individuals. However, our overall analyses failed to reveal a significant interaction between age, category and inference type, preventing us from concluding that social inferences are selective in the types of inferences that are made, the age at which the inferences are made, and the categories one which these inferences are based.

General Discussion

Children, from very early on, are sensitive to various cues that allow them to organize their social world into categories which, in turn, allow them to make adaptive inferences. A crucial inference is about the ingroup/outgroup status of individuals. As noted in the introduction, we mean by “group” a set of humans who are linked by a network of regular, direct social interactions, because these are the units of social organization that seem most relevant for survival in ancestral societies. However, it is unclear which cues young children use to infer group-membership based on certain social categories, and whether these cues change over development. The present research starts addressing these issues. Our experiments are based on the idea that, in ancestral societies, two individuals could share knowledge of cultural traditions only if they belonged to the same group. Further, young children’s social preferences seem to be driven by just this

kind of shared knowledge (Soley & Spelke, in review); their social behavior thus reflects the diagnostic relation between shared knowledge and group membership.

As a first step to address the cues children use to infer group membership as well as their development, we used inferences of shared knowledge as a proxy of inferences of group membership, and ask if children attribute shared musical knowledge or shared music preferences similarly to individuals of the same race or gender.

Results of Experiment 1 show that inferences about shared knowledge differentially change over development depending on the social category on which these inferences are based: Four-year-old children infer that two individuals of the same gender are more likely to share knowledge than two individuals of different genders, but make no such inferences based on race. In contrast, five-year-olds infer that two individuals of the same race are more likely to share knowledge, but make no such inferences based on gender. Thus, between four and five years of age, children become more likely to infer that two individuals of the same race share knowledge, and less likely to infer that two individuals of the same gender share knowledge. This developmental pattern might reflect children's realization that gender is not predictive of group membership in most human groups. In contrast, in Experiment 2, no such developmental changes were observed when children were asked to infer whether two individuals shared musical preferences: Both four- and five-year-olds draw inferences based on gender, while only five-year-olds draw inferences about shared preferences based on race.

The design difference between the race and gender conditions leaves open an alternative interpretation to the children's increased sensitivity to race as a social cue. Namely, the developmental pattern in the race condition might reflect developmental

changes in the children's ability to deal with the increased variability of the race condition. While our experiments leave open this possibility, we note that previous research demonstrates that four-year-old children lack robust representations of race as a social category (e.g., Aboud, Mendelson, & Purdy, 2003; Kinzler & Spelke, 2011; Shutts, Banaji, & Spelke, 2010), suggesting that they were most likely not any more sensitive to this category than in previous studies.

While, previous research notwithstanding, our experiments do not allow us to decide between an developmentally increasing sensitivity to race cues and an developmentally increasing ability to deal with variability, our crucial result is that children's propensity to infer shared knowledge based on gender cues decreased considerably with age, while no such decrease was observed in their propensity to infer shared preferences.

Accordingly, our separate analyses for each age group across two experiments yielded a marginal interaction between category and inference type, but only in five-years old children, suggesting that older children may be selective in the kinds of inferences they make based on the social categories of race and gender. Such a dynamic updating of the social categories based on which children make social inferences appears adaptive. Indeed, while children are likely to have the ability to add social categories to their existing categories, simply adding categories to the inventory of social categories will not be useful unless the inferences that are based on such categories are selective. However, our results suggest that children can avoid those potential problems. They seem to be able to stop making certain inferences based on categories such as gender, suggesting that they can prune some categories from their inventory of categories on which they base

inferences such as shared knowledge. Our results thus raise the possibility that children may adaptively update the kinds of categories based on which inferences of group-membership are licensed.

The pattern of results of Experiments 1 and 2 suggest that children's inferences about shared knowledge should change as a function of age and category, and that no such trends should be observed in children's attributions of shared preferences. However, based on this view, we would also expect an interaction between age, category and inference type, and this interaction failed to reach significance in our overall analyses. This prevents us from concluding that, overall, children are selective in the kinds of social inferences they make about shared knowledge based on the social categories of race and gender.

Importantly, while the view that children are sensitive to the most reliable markers of group membership would be consistent with a selective attribution of shared knowledge to specific social categories, there are at least two reasons for which such attributions might not be selective. First, shared knowledge might simply not be a useful proxy to test children's group-membership inferences. As we discussed in the introduction, while previous findings (Soley & Spelke, in review) show that children selectively attend to this cue when choosing among two potential social partners, such results do not guarantee that an inverse inference will take place. Second, the social categories of race and gender may not fulfill our definition of social groups; if so, attributions of shared knowledge should not be selective based on these two categories either. Social categories such as race might not fulfill our definition of a group, because members of a race have no direct contact with most other members of their race.

Likewise, the category of gender might not fulfill the definition of a group because the most enduring social groups such as families and tribes include both genders. Thus, our experiments might not reveal selective attribution of shared knowledge based on these categories because these social categories might not correspond to social groups in the first place, raising the possibility that children would attribute shared knowledge only to members of those categories that also constitute social groups.

For future research, it is important to investigate whether children's attributions would be selective for other social cues. Language and accent are prime candidates for such investigations. Social effects due to language and accent arise as early as five months of age, and are maintained in older infants and children (Kinzler et al., 2007). Moreover, language and accent seem to have a particularly privileged status, given that they can overcome the effects of race in terms of social preferences (Kinzler et al., 2009). Current experiments might not reveal selective attribution of shared knowledge based on the categories of race and gender, because these social categories might not correspond to social groups in the first place, raising the possibility that children would attribute shared knowledge only to members of those categories that also constitute social groups, which, in turn, might allow them to thrive in their social environment.

Conclusion

Human attention to social cues arises very early in life and has important social implications. This dissertation explores the nature of early social categories and preferences and asks which cues infants and young children attend to primarily when choosing between possible social partners, and whether these social preferences might reflect a sensitivity to others' group membership. To investigate this issue, it uses music-based social preferences in infants and children as a case study.

Given the importance of social interactions in human societies, reliably identifying ingroup and outgroup members likely confers important fitness benefits to individuals, favoring individuals who attend to cues that are diagnostic of shared group membership. As discussed extensively in the introduction, cultural knowledge might be a relatively reliable marker of shared group membership, because the acquisition of such knowledge requires social interactions with other group members. As a result, humans might have evolved a sensitivity to this cue, and such a sensitivity might arise very early in life.

In line with these predictions, Part 1 of this dissertation showed that social preferences in four-and-five year-old children were driven by a shared state of cultural knowledge: Children both preferred others who knew songs they themselves knew, and avoided others who knew songs they did not know. In contrast, children showed no tendency to prefer others who liked the songs they themselves liked, and avoid others whose song preferences differed from their own. Interestingly, social effects of music were only observed when the songs differed in terms of familiarity, or when the songs differed in terms of the conformity to the universal musical rules. In contrast, there were

no clear effects of familiarity with the general musical conventions of our participants' own culture. Even though children judged that unfamiliar songs that followed the conventions of their own culture were more like the music they knew, they showed no preference for target children associated with these songs.

The results of Part 1 suggest that children's attention to shared cultural knowledge might reflect its status as a relatively reliable marker of shared group membership, and that even young children selectively attend to those cues that signal group membership most reliably. There are at least two reasons that might favor attention to specific songs rather than musical style in distinguishing group members, both of which are related to how diagnostic either cue is of group membership. First, individual songs can be recognized even when they are badly performed by a person who sings out of tune or misses the beat. In contrast, given the variance in people's music performance skills (Pfordresher & Brown, 2007; Pfordresher, Brown, Meier, Belyk, & Liotti, 2010), it is hard to distinguish whether an individual produces music in an unfamiliar musical style, or rather poorly produces music in a familiar style, suggesting that musical styles might not allow listeners to distinguish ingroup from outgroup members due to perceptual constraints. Second, in our evolutionary past, individuals were unlikely to encounter other agents from a culture with different musical conventions, because the typical range of a hunter-gatherer was most likely too small to encounter different musical cultures (Nettl, 1983). In contrast, even neighboring groups likely differed in their repertoire of specific songs. Therefore, prior to the introduction of rapid, long-distance travel, knowledge of specific songs may have been a good cue to group membership while knowledge of a

musical style may not have allowed individuals to distinguish ingroup from outgroup members.

Based on these predictions and the results of Part 1, Part 2 further investigated the developmental origins of the predisposition to choose social partners based on shared musical knowledge. Five-month-old infants exhibited a visual preference for individuals who previously sang a familiar song over agents who sang an unfamiliar (tonal or atonal) song. In contrast, when infants were presented with two singers who both produced unfamiliar songs, they showed no preference between them, even though one song followed the characteristic structure of Western melodies, whereas the other did not and was atonal. As discussed above, it is possible that differences in the number of directional contour changes in the familiar vs. unfamiliar melodies might have contributed to this pattern of results, at least under the assumption that musical preferences are determined by the number of contour changes. Regardless, the findings of Part 2 at least suggest that song familiarity rather than familiarity with musical structure might have a privileged status in guiding infants' attention to social partners. However, further controls are needed to be able to firmly conclude that song familiarity itself is sufficient to guide infants' attention to individuals.

Building on these results, Part 3 investigated whether children are selective in the properties they use to infer that two individuals belong to the same group, by testing whether children infer that individuals of the same race or gender share musical knowledge or musical preferences. Results showed that four-year-old but not five-year-old children attributed shared knowledge to individuals of the same gender, while five-year-old but not four-year-old children attributed shared knowledge to individuals of the

same race. Further, while children of both ages attributed shared preferences based on gender, only five-year-old children attributed shared preferences based on race. The lack of four-year-olds' attributions based on race cues might reflect the possibility that four-year-olds are less sensitive to race cues compared to gender cues. While, in our experiments, the developmental pattern in the race condition might also reflect developmental changes in the children's ability to deal with the increased variability of the race condition, previous research is not conclusive regarding own-race preferences in children younger than five years of age (Aboud, 2003; Aboud, Mendelson, & Purdy, 2003; Aboud & Skerry, 1984; Kinzler & Spelke, 2011; Kircher & Furby, 1971; Shutts, Banaji, & Spelke, 2010; Stevenson & Stevenson, 1960). The alternative interpretations of the race condition notwithstanding, the results of Part 3 suggest that children become less willing to make inferences about shared knowledge based on gender as they become older. In contrast, no such decrease with age was observed for inferences of shared preferences. This may suggest that, as children gain more experience with social categories, they prune some categories, and retain only the more relevant categories to make attributions and inferences.

Together the findings from this dissertation suggest that shared cultural knowledge is not only a particularly useful cue to group-membership and that sensitivity to it develops very early in life, but also that increased experience with the social world might lead children to dynamically update the social categories on which they base inferences about shared knowledge and, therefore, shared group-membership.

Reliability of shared cultural knowledge as a cue to group membership

If shared knowledge is used as a cue to group membership, one needs to ask how reliable it is; after all, individuals can suffer crucial fitness consequences from mistakenly identifying ingroup or outgroup members. Compared to other social cues to which children are sensitive, including shared preferences (Fawcett & Markson, 2010), attitudes (Byrne & Griffitt, 1966), and beliefs (Heiphetz, Spelke, & Banaji, 2011), shared knowledge has a crucial advantage on top of those discussed earlier: it can be assessed objectively and is, therefore, verifiable. For example, to evaluate an individual's knowledge of a song, one can simply ask her to sing along with the song. In contrast, one can just pretend to like a song, without any possibility of verification.

However, compared to other cues like accents or dialects, knowledge of songs can be acquired much more easily, thus raising the questions of its reliability as a cue to group membership. However, even if it is easy to learn new songs, the acquisition of such knowledge requires social interactions with other group members; for example, to learn a new song, one needs to engage in social interactions with another agent who knows the song. As a result, individuals who share such knowledge are most likely in-group members in the first place, thereby reducing the risk of dishonest signals about group membership. Hence, it seems that shared knowledge is both diagnostic of shared group membership, and easily verifiable.

Nature, nurture, and the development of social cognition

The present findings have important implications regarding the respective roles of nature and nurture in social development. Children's early sensitivity to shared

knowledge raises the possibility that humans might have evolved a bias to specifically attend to this cue as a marker of group membership. However, the results of this thesis also show that these biases develop with considerable plasticity and flexibility. For instance, the results from Part 3 show that inferences about shared knowledge differentially change over development as a function of the associated social categories: Between four and five years of age, children become more likely to infer that two individuals of the same race share knowledge, and less likely to infer that two individuals of the same gender share knowledge. While the current results do not allow us to conclude whether the increased propensity to infer shared knowledge among same-race individuals is because children get better in dealing with this complexity or to an increased sensitivity to race cues, previous research suggests that they become increasingly sensitive to race cues as they get older. Be that as it might, the decrease in children's propensity to infer shared knowledge between same-gender individuals as they get older suggests that they dynamically change their social inferences as a function of their experience, (e.g., social groups in their environments may be segregated more by gender than race), demonstrating that experience is of crucial importance for how we interact with others.

A particularly interesting possibility is that these biases might further change throughout life. For example, adults have spent many years of their lives using media, sharing different kinds of knowledge with others without ever being in direct social contact with them. As a result, while they might still show similar explicit or implicit biases towards others who share their state of cultural knowledge, they might also lose this bias through experience, and cease to make similar inferences about shared

knowledge based on different social categories like gender and race. It will be an important topic for further research to address this issue empirically.

A new evolutionary function of music

The evolution of music has remained a riddle, especially with regard to its function. Different authors have suggested that it evolved to fulfill a variety of social functions (e.g., Cross, 2001; Huron, 2001; Miller, 2000), including attracting mates (Darwin, 1872, Miller, 2000) and increasing group cohesion (Roederer, 1984); others suggested that it evolved as a side effect of language (e.g., Pinker, 1997), and still others that it evolved for its own, music-specific purposes (e.g., Peretz, 2006). This dissertation suggests another potential social function of music for humans: it might be an important and reliable marker of group membership. Music is considered as one of the human universals and has been an important part of every human culture throughout history (Brown, 1991). Moreover, sensitivity to music starts very early in life (for a review, see Trehub, 2003), raising the possibility that it might have a privileged status as a social cue.

However, while shared musical knowledge might be used to identify ingroup and outgroup members, cultural groups also share other knowledge such as specific traditions, rituals or folk tales. Consequently, it is an important question for future research to determine the specificity of cues to group-membership. Would these other forms of cultural knowledge lead children and infants to make similar social choices as shared musical knowledge, or is music unique in driving knowledge-based social preferences? Such research might ultimately reveal both the underpinnings of our social mind and its evolution, as well as a novel potential evolutionary function for music.

Shared knowledge as a proxy for social group membership

In addition to providing theoretical clarifications about the mechanisms that drive social preferences early in life, the current research also provides a new methodological tool for investigating the development of social cognition. Specifically, the current findings suggest that shared knowledge might be a useful proxy for determining whether participants make group-based inferences as opposed to expressing other social preferences that are not linked to social groups. This essay opens up new perspectives in the study of early social cognition. For example, it may allow us to investigate, which other social categories lead to group-based inference.

Language and accent are prime candidates for such investigations. Social effects due to language and accent arise as early as five months of age, and are maintained in older infants and children (Kinzler et al., 2007). Moreover, language and accent seem to have a particularly privileged status, given that they can overcome the effects of race in terms of social preferences (Kinzler et al., 2009). Would children infer shared cultural knowledge between individuals who speak the same language? How would children's (and adults') inferences change, when these different cues were pitted against each other? These studies may help us better understand the underlying mechanisms of early social choices that children make based on these various social categories and give us insight about why certain social categories are more privileged than others in eliciting social preferences.

Further explorations of infants' music-based social preferences

Another question that arises from this research concerns infants' early biases in attending to certain individuals rather than others. More specifically, future research needs to explore the specificity of these effects. For instance, both the current findings from Part 2 as well as in research showing language-based preferences in infants (Kinzler et al., 2007) reveal infants' visual preferences for unfamiliar individuals, based on the sounds the individuals produced in the past. Are these preferences tightly linked to specific individuals, to the extent that they need to produce sounds? Or would more general associations, potentially reflecting social interactions, (e.g., dancing in synchrony with music) be sufficient to elicit similar preferences in infants? Some preliminary findings suggest that clapping in synchrony with music yields similar results as singing. Using identical methods, songs and actors as in Part 2, ongoing follow-up studies suggest that infants attend more to those individuals who previously clapped to familiar songs compared to individuals who clapped to unfamiliar songs (Soley, Hannon, & Spelke, in prep). Moreover, songs in this study are played by instruments and have no lyrics, suggesting that the melody itself is enough to elicit such preferences and thus infants' responses are not driven by other factors such as lyric-tune congruity.

Second, even though previous research suggests that young infants are sensitive to the distinction between tonal and atonal melodies (Cohen, Thorpe, & Trehub, 1987; Trehub, Thorpe & Trainor, 1990), neither current research nor previous research has directly tested infants' preferences for tonal melodies over atonal ones. Therefore it is possible that even though infants are sensitive to the distinctions between the tonal and atonal melodies, their affective responses to these distinctions may not be mature enough to be generalized to preferences for individuals who sing or clap to these melodies.

Greater sensitivity to familiar songs than to tonality or to culture-specific traditions might reflect the relative adaptiveness of these cues for choosing among social partners. Further follow-up studies with other musical comparisons (e.g., consonant vs. dissonant songs, or songs with a Western rhythm vs. a highly complex, arbitrary and unfamiliar rhythm) also reveal parallel findings to those that we found in the tonal-atonal comparison (Soley, Hannon, & Spelke, in prep). These findings are intriguing, because such musical comparisons elicit very robust preferences for the musical stimuli itself in young infants. For instance, even newborns prefer consonant tone-pairs to dissonant ones (Masataka, 2006; Trainor, Tsang and Cheung, 2002; Zentner & Kagan, 1996) and infants as young as 4 months of age prefer melodies having a simple, regular Western rhythm to melodies with more complex rhythms (Soley & Hannon, 2010). Nevertheless, we find no evidence that these musical comparisons elicit visual preferences in infants, using identical methods that revealed such preferences with specific, familiar songs. These findings, thus, provide further support for the findings that, first, familiar songs, rather than familiar or pleasant musical styles guide young infants' visual preferences.

The present findings also present new perspectives on past results revealing language-based social preferences in early infancy and childhood. These studies revealed that, after listening to two individuals speaking in different languages, five-month-old infants showed a visual preference for the speaker of the infants' native language (Kinzler et al., 2007). The results of this dissertation raise the possibility that, also in the language case, social preferences might be driven by familiarity with specific items. That is, infants' visual preferences for speakers of their native language might be driven by familiarity with specific (frequent) words rather than by a more abstract familiarity with

the sound of the language. Exploring these possibilities with future studies may provide us insight about how infants' early experiences and attentional biases shape their later social preferences, and might suggest a novel interaction between language acquisition and the development of social preferences.

How do early social biases affect the formation of preferences and learning?

Past research suggests a bidirectional relationship between the social preferences of children and other types of preferences. For instance, children prefer individuals of their own race and gender, and, in turn, these preferences guide their preferences for objects or activities that are endorsed by children of their own gender and race (Shutts et al., 2010). However, this reverse relationship has not received as much attention in infancy. For instance, very little is known about social factors that might be contributing to the formation of early auditory preferences of infants. Infants are intrinsically sensitive to ostensive cues like eye-contact or infant-directed speech (Farroni, Massaccesi, Pividori, Simion & Johnson, 2004; Masataka, 2003), which are argued to play a fundamental role in early learning (Csibra & Gergely, 2006). Together with the present results, such research raises a crucial question: How do exposure and other social factors such as infants' sensitivity to social and communicative cues facilitate the formation of early auditory preferences, and how do these early preferences and biases affect future learning and perception? For example, would infants prefer a particular song, or learn it better if it is sung by an individual, who is likely to be from their own social group (e.g., who speaks with a native accent)?

Final conclusions

The present research proposes that shared cultural knowledge is a reliable indicator of shared group membership, and shows that attention to this cue arises early in life, and guides young children's social preferences. The results provide new perspectives on social cognition, its development and its evolution, and open up new methodological avenues for investigating the development of social cognition. Such investigations might bring us closer to understanding the evolutionary and developmental roots of the complex and flexible social organization of human societies.

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Appendix: Additional data and analyses for Part 3

A1. Own-gender vs. opposite-gender trials of the race conditions across Experiments 1 and 2.

Both Experiments 1 and 2 contain an asymmetry between the race and gender conditions. In the race conditions, half of the trials involved children who matched the participants in gender and half did not; in the gender conditions, in contrast, all the trials involved children who matched the participant in race. To evaluate the effect of whether or not the gender of the photographs matched the participants' gender, we present further analyses below.

First, we compared children's performance in those trials where the gender of the children on the pictures matched the participant's gender to their performance in those trials where the gender of the children on pictures did *not* match the participant's gender. Overall, we found no significant difference in children's performance between trials where the gender of the stimuli matched the participant's gender (percentage of choosing the child matching the race of the sample picture: $M = 64.4\%$, $SD = 27.7\%$) and trials where it did not ($M = 60.2\%$, $SD = 30.4\%$), $t(63) = 1.1$, $p = .287$, *ns*, two-tailed, paired-sample t-test).

We also analyzed the matching vs. non-matching trials separately for younger and older children's generalizations. We observed no significant differences between trials where the gender of the stimuli matched the participant's gender and where it did not, neither for four-year-old children, $t(31) = 1.38$, $p = .177$, nor for five-year old children, $t(31) = .138$, $p = .891$.

A2. Separate analyses for trials where the children on the pictures match the participants' gender in the race conditions.

As a second step, we further analyzed the data set by only including the subset of trials of the race conditions where the stimulus children matched the participants in gender.

A2.1 Experiment 1: Inferences of shared knowledge

To compare the results of the Race and Gender conditions in Experiment 1 after restricting the trials in this way, we analyzed participants' choices for the same-category photograph using an ANOVA with age (four vs. five years) and type of category (gender or race) as between-subjects factors and familiarity (whether the song was familiar or unfamiliar to the participant) and match (whether the gender or the race of the sample photograph matched the participant's race or gender) as within-subject factors. We observed a significant interaction between category and age, $F(1,60) = 4.44$, $p = .039$. Further, we obtained a main effect of match $F(1,60) = 8.77$, $p = .004$, a significant interaction between match and familiarity ($F(1,60) = 4.38$, $p = .04$) and a significant interaction between familiarity, match, age and category, $F(1,60) = 4.38$, $p = .04$. No

other significant main effects or interactions were observed (see Figure A1). In other words, these analyses confirm the analyses reported in the main text above.

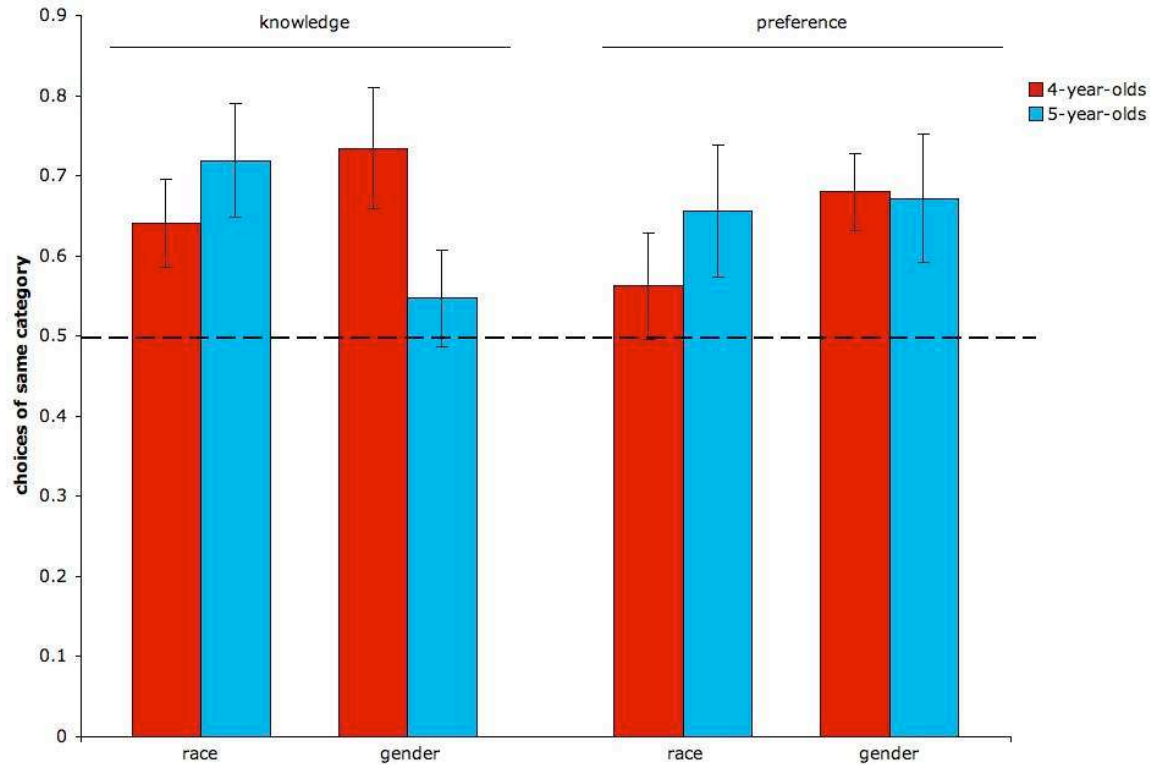


Figure A1. Children's choices of same category pictures for the subset of trials of the race conditions in which the stimulus children matched the participants in gender.

A2.2. Experiment 2: Inferences of shared preferences

In Experiment 2, an ANOVA with age (four vs. five years) and type of category (gender or race) as between-subjects factors and familiarity (whether the song was familiar or unfamiliar to the participant) and match (whether the gender or the race of the sample photograph matched the participant's race or gender) as within-subject factors, did not yield any significant main effects or interactions. In other words, these analyses confirm the analyses reported in the main text above.

A2.3. Comparing Experiments 1 and 2

We conducted an omnibus ANOVA with age (four vs. five), social category (gender vs. race) and inference type (knowledge vs. preference, that is, Experiment 1 vs. 2) as between-subjects factors, and familiarity (whether the song on a given trial was familiar or unfamiliar) and match (whether the gender or the race of the sample photograph on a given trial matched the participants' gender or race) as within-subject factors. We found a significant main effect of match, $F(1,120) = 9.93$, $p = .002$, a marginal interaction

between match and category, $F(1,120) = 3.29, p = .072$, and between age and category, $F(1,120) = 3.62, p = .059$. We also found a significant three-way interaction between familiarity, match and inference type, $F(1,120) = 5.17, p = .025$, a marginal four-way interaction between familiarity, match, age and category, $F(1,120) = 3.22, p = .075$ and a marginal four-way interaction between familiarity, match, category and inference type, $F(1,120) = 3.22, p = .075$. All other main effects and interactions were non-significant. These findings parallel previous findings with the exception of the interactions with familiarity. In initial analyses in the main text above, we did not find any significant interactions with familiarity. To follow up on this interaction, Appendix A4 presents separate analyses for trials with familiar and unfamiliar songs, respectively, as a function of the match between sample pictures' and participants' race and gender.

A3. Trials in which the sample picture matched the participants in both gender and race

Below, we restrict our analyses to the subset of trials in which the sample picture matched the participants in both gender and race, for both the gender and the race condition (see Figure A2). These data represent four trials per participant in the gender conditions, and two trials in the race conditions. Hence, while the pattern of the results still hold, the comparisons become non-significant due to larger error bars.

It is important to note that it is not meaningful to compare each of these bars to the chance level of 50%, because the graph below shows only matching trials. Thus, subjects might differ from chance because they make inferences, or simply because they prefer persons of the own gender/race.

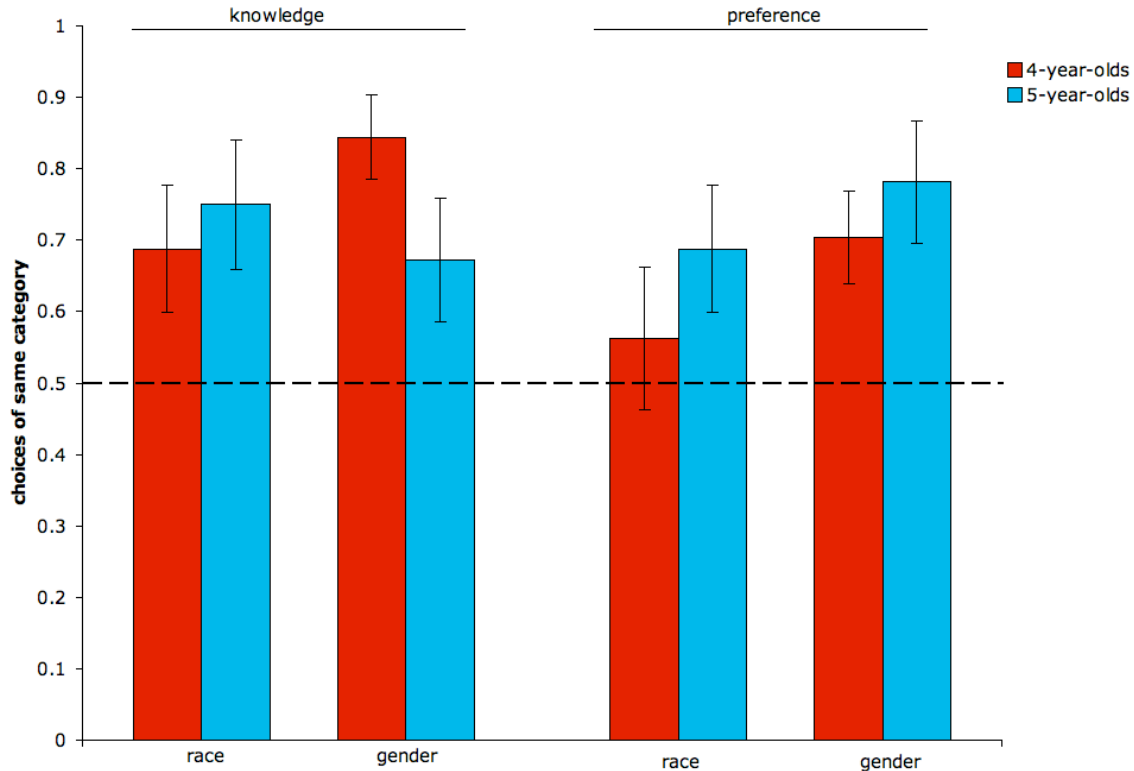


Figure A2. Children's choices of same category pictures for the subset of trials in which the sample picture matched the participants in both gender and race

A4. Separate analyses for trials with familiar and unfamiliar songs, as a function of the match between sample pictures' and participants' race and gender

Below are shown children's choices of same category pictures separately for trials with familiar and unfamiliar songs as a function of match between the race and gender of the sample pictures and the participants (see Figures A3a and A3b). We show only the subset of trials of the race conditions where the participants' gender matched the sample picture's gender. As revealed by the three-way interaction between familiarity, match and inference type (see Appendix A2.3), children tended to generalize knowledge of familiar songs to same-race and same-gender individuals when the sample picture matched their own social category. Conversely, they tended to attribute shared knowledge of unfamiliar songs more when the sample picture did not match their own social category. In contrast, they showed the opposite pattern when they generalized preferences for songs: overall, they tended to generalize preferences for familiar songs when the sample picture was from opposite gender or race. They were also more likely to generalize preferences for unfamiliar songs when the sample picture was the same gender as themselves.

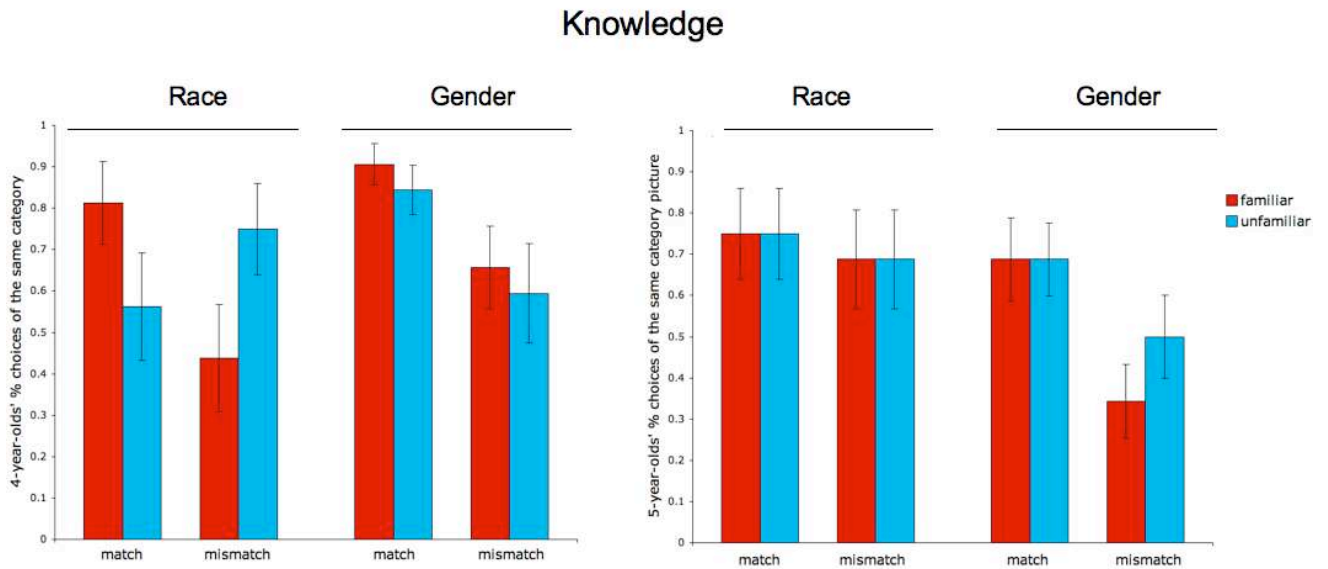


Figure A3a. Children’s generalizations of shared knowledge, separately shown for trials with familiar and unfamiliar songs, as a function of the match between sample pictures’ and participants’ race and gender

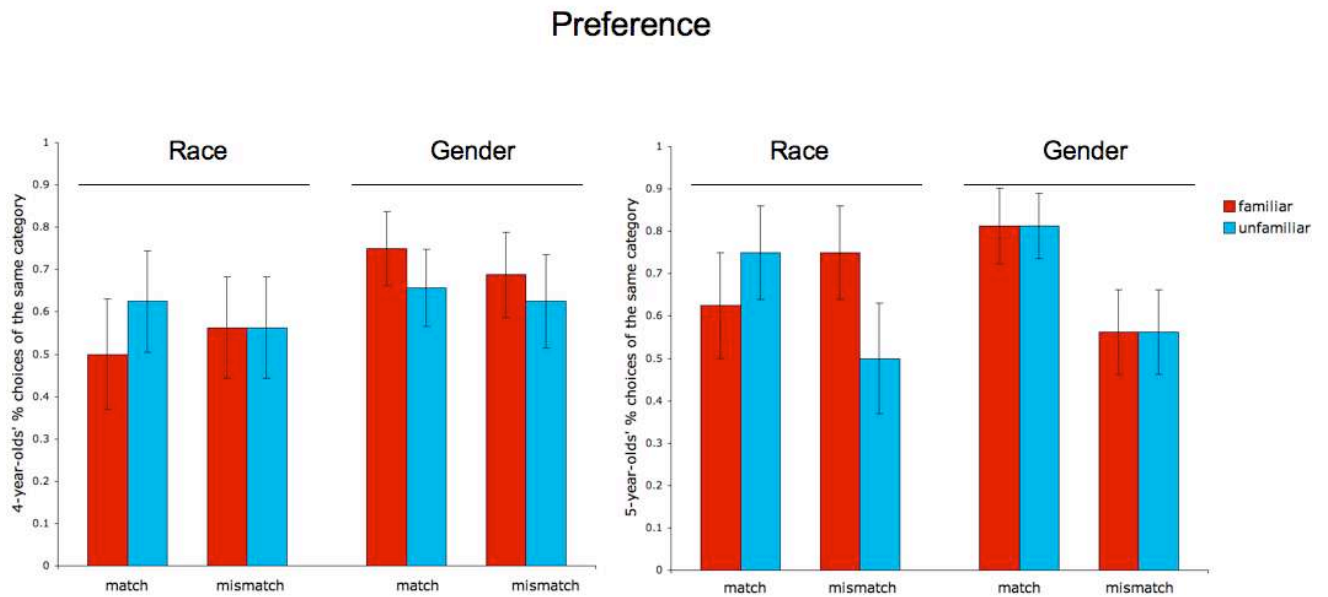


Figure A3b. Children’s generalizations of shared knowledge, separately shown for trials with familiar and unfamiliar songs, as a function of the match between sample pictures’ and participants’ race and gender

A5. Homogeneity of the populations

In the race condition, all children in the final sample were white. In contrast, the sample included 4 non-white (3 Asian and 1 black) children in gender conditions. Because these different restrictions regarding the race of participants in these two conditions could have contributed to the different patterns of results reported in the main text, we re-analyzed the results by excluding these four non-white participants from our final sample

To compare the results of the Race and Gender conditions in Experiment 1, we analyzed participants' choices for the same-category photograph using an ANOVA with age (four vs. five years) and type of category (gender or race) as between-subjects factors and familiarity (whether the song was familiar or unfamiliar to the participant) and match (whether the gender or the race of the sample photograph matched the participant's race or gender) as within-subject factors. We observed a significant interaction between category and age, $F(1,58) = 7.21, p = .009$. Further, we obtained a main effect of match $F(1,58) = 11.66, p = .001$, and a significant interaction between match and category, $F(1,58) = 5.072, p = .028$. No other significant main effects or interactions were observed. In Experiment 2, regarding children's generalizations of preferences for songs, we observed no significant main effects or interactions with the exception of a marginally significant main effect of match, $F(1,58) = 3.062, p = .085$. These analyses confirm the analyses reported in the main text above.

We conducted two additional ANOVAs with type of social category (gender vs. race) and inference type (knowledge vs. preference) as the between-subjects factors and familiarity (whether the song on a given trial was familiar or unfamiliar) and match (whether the sample picture matched the participant's own gender or race on a given trial) as the within subject factors to test the effects of these factors and the interactions separately for each age group. In four-year-old children, we found a significant main effect of social category, $F(1,58) = 4.71, p = .034$, a marginal effect of match, $F(1,58) = 2.97, p = .09$, and a marginal interaction between category and familiarity, $F(1,58) = 3.56, p = .064$, but no other significant main effects or interactions. In five year old children, we found a marginal interaction between category and inference type, $F(1,58) = 2.786, p = .1$, a significant main effect of match, $F(1,58) = 12.03, p = .001$, and a significant interaction between match and category, $F(1,58) = 5.23, p = .026$. No other significant main effects or interactions were observed.

Finally, we conducted an omnibus ANOVA with age (four vs. five), social category (gender vs. race) and inference type (knowledge vs. preference) as the between-subjects factors, and familiarity (whether the song on a given trial was familiar or unfamiliar) and match (whether the gender or the race of the sample photograph on a given trial matched the participants' gender or race) as the within-subject factors. We found a significant main effect of match, $F(1,116) = 13.15, p < .001$, a significant interaction between match and category, $F(1,116) = 4.55, p = .035$, between age and category, $F(1,116) = 5.83, p = .017$, and a marginal three-way interaction between familiarity, age and category, $F(1,116) = 3.22, p = .075$. All other main effects and interactions were non-significant.

Given that the above findings are parallel to what we have obtained previously and reported above in the main text, we conclude that the differences between the race and gender conditions are unlikely to be driven by the different restrictions regarding the race of participants in these two conditions.

A6. Summary

The additional data and analyses presented above aimed to evaluate the effect of whether or not the gender of the photographs matched the participants' gender in the race conditions.

We first compared children's overall performance in same-gender vs. opposite-gender trials of the race conditions and showed that children's performance was similar on same-gender and opposite gender trials in both Experiments 1 and 2 (Appendix 1).

Second, we repeated the analyses reported in the main text, but only including the subset of trials of the race conditions where the stimulus children matched the participants in gender. (All trials of the gender conditions were included.) Both the separate analyses for Experiments 1 and 2 and the overall analysis comparing Experiments 1 and 2 yielded results that closely parallel the findings reported in the main text, with the exception of a significant three-way interaction between familiarity, match and inference type (Appendix 2).

Third, we followed up on the interaction by presenting additional data on trials with familiar and unfamiliar songs, as a function of the match between sample pictures' and participants' race and gender. These data suggest that children tended to generalize knowledge of familiar songs to same-race and same-gender individuals when the sample picture matched their own social category. Conversely, they tended to attribute shared knowledge of unfamiliar songs more when the sample picture did not match their own social category. In contrast, they showed the opposite pattern when they generalized preferences for songs: overall, they tended to generalize preferences for familiar songs when the sample picture was from opposite gender or race. They were also more likely to generalize preferences for unfamiliar songs when the sample picture was the same gender as themselves (Appendix 4).

We also presented additional data for those trials in which the sample picture matched the participants in both gender and race. While, due to the small number of trials, the comparisons become non-significant, the general pattern of the results is still similar to the results reported in the main text (Appendix 3).

Finally, to address another possible interpretation of difference between the race and the gender condition, we applied the same selection criteria to the participant population in both conditions, excluding four non-white participants from the gender condition. (In the race condition, all participants were white). The results reported in Appendix reveal are similar to those reported in the main text.

Taken together, these additional analyses support the results presented in the main text. However, while these findings suggest that overall, children's performance on trials with same-gender photographs did not differ from those with opposite-gender photographs in the race conditions, they still leave an alternative interpretation open. The lack of four-year-olds' attributions based on race cues might reflect the possibility that four-year-olds are less sensitive to race cues compared to gender cues; alternatively, four-year-olds might not make any inferences based on race due to the more complex design in the race condition, and the developmental pattern in the race condition might reflect developmental changes in the children's ability to deal with the increased variability of the race condition. While our experiments leave open this possibility, we note that previous research demonstrates that four-year-old children lack robust representations of race as a social category (e.g., Aboud, Mendelson, & Purdy, 2003; Kinzler & Spelke, 2011; Shutts, Banaji, & Spelke, 2010), suggesting that they were most likely not any more sensitive to this category than in previous studies.

The alternative interpretations of the race condition notwithstanding, both the results in the main text and those presented here suggest that children become less willing to make inferences based on gender as they become older, suggesting that they might dynamically update the categories based on which they make social inferences.